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THE HARMONIZING OF ORGANIZED LABOR WITH ORGANIZED CAPITAL.

By M. Cokely.

There is no more vital need today than that of applying to the labor question the same enlightened common sense which has lately revolutionized machine-shop equipment and practice. Mr. Cokely's article is earnestly commended as expressing, clearly and concisely, the spirit and method which must direct the change—which by their spread will cause the change. It is a striking statement of the concept underlying the system described in these pages by Mr. Carpenter last month. No shop is too small and no works too large for its full application.—THE EDITORS.

ONE of the most important problems under public consideration at this time is the prevention of what is considered a threatened conflict between labor and capital. In providing a remedy for any trouble it is necessary to know the causes. In this particular case the cause is deep-seated and one that, strange to say, it would be fatal to remove—because it is a virtue as well as a source of trouble. Ambition is the mischief maker. The ambition of the workman under the ever increasing light of civilization is to better his condition. With increasing enlightenment he becomes less satisfied with his present position, and as the same light by which he sees the undesirable features of his condition shows him the means by which he can improve it, his animal nature asserts itself and he makes use of those means.

The same is true of his employer—ambition is what makes an employer of him, and in both cases gratification merely acts as a stimulus to a greater and an increasing ambition. Like the sublime and the ridiculous, there is but a single step between honorable ambition and avarice, and the danger arises when, blinded with greed, both parties

are driven in opposite directions on the same road with the inevitable collision as a result. Notwithstanding this, I claim that this very ambition is a sublime virtue when properly controlled and directed, and is as much a necessity to the perfection and development of the human race as any other influence that we know of.

The ambitions of men vary according to their nature and position in life. With the majority it is wealth, fame, and glory, while a small sincere minority are led along spiritual lines by what we might term a negative ambition and exercise a necessary restraining influence on the majority. That with which we have to deal in this article, however, is wealth—the desire for money and all the comforts and luxuries which it is supposed to supply. That kind of ambition which we find planted in the human breast is as necessary to the well-being and perpetuity of humanity as the sunshine is to the vegetable kingdom. Without it all would be chaos; we would stagnate and finally cease to exist. We are on earth for something more than a mere existence —we are here to discover the secrets of nature, develop her resources, and in doing so work out our own destiny and, if possible, lighten the burdens of all humanity. This can be accomplished only under the stimulating influence of the desire for worldly possessions. For that reason I consider ambition, even of that kind, a divine attribute and not in conflict with divine teaching. There is nothing harmful or immoral in the mere pursuit or possession of wealth; it is only the methods by which it is acquired and the uses to which it is applied that are open to question.

On this theory, then, both the employer and the employed are justified in securing even from the same source of supply all the wealth they can possibly obtain consistent with the rights of all concerned. This brings up the question of their respective rights in the pursuit of wealth and the realization of their ambition. That of the workmen to organize for mutual protection and advancement is undoubted, and their right to leave their employer's service when dissatisfied with existing conditions should be unquestioned—but not under an official order from their organization; this, I think, will mark the limit of any sustained legal ruling in the United States. Once out of their employer's service, however, no matter what their grievance may have been, they have no legal or moral right to interfere with or injure his business in any way either directly or indirectly. Local conditions being considered, they have a right to at least the average wages of their trade throughout the country, and at all times the undoubted right to a sufficient wage when honestly earned and

judiciously expended to support their families in conformity with national standards of living. On the other hand, the employer should have the right to hire or discharge anyone he may consider necessary to the success of his business—as many or as few of any particular trade or calling as he in his judgment requires to insure profitable returns from his investment. This right of the employer, with that of the employee to sell his skill and labor in any market and at any price and to terminate his service at any time, are sacred and fundamental and as necessary to the welfare of the people as the freedom of speech or the liberty of the press. No abridgment of these privileges should be tolerated, excepting through private contract and mutual consent. In no charter issued by any state is it stipulated that the company so chartered shall employ any particular man or body of men, or pay any particular rate of wages; and when they have satisfied all legal and moneyed conditions necessary to secure the privilege of establishing and operating their business, they have done all that can be expected of them, and should not be compelled to employ anyone objectionable to them, as every employer of labor knows that all help forced on him is practically worse than no help at all.

This theory is contrary to the oft-repeated and humane sentiment that labor is entitled to a chance to earn a living. True—labor is entitled to such a chance; but no one—not even the State—has a right to say to any employer that he must give any particular labor a chance to make a living in his employ, particularly when the employment of such labor would be detrimental to his interests. Better by far that all employers of labor should be taxed for the support of those who cannot get a chance to make a living, if such there be, than to interfere with the management of their private business.

It seems like a natural law when viewed from a moral standpoint that responsibilities are in direct proportion to privileges. The former are morally inseparable from the exercise of the latter, and when we claim for the employers the rights and privileges mentioned in the foregoing, it is with the understanding that they should realize this incontrovertible fact, that there is in the population a preponderant element of rational human beings dependent on them, and them alone, for all that makes life worth the living. Stop all employment of labor and we will have barbarism; employ all labor and we will have civilization. It is through the free exchange of a unit of mental or physical effort for its equivalent in wealth that the human race is evolving from barbarism to civilization. It is necessary, then, that employers should realize this truth and take a broad view of the importance of

their position, because with them more than any other class rests the responsibility for their country's commercial and industrial success and the welfare of all its inhabitants.

How are they to fulfil this obligation under present conditions? By the formation of a universal organization of employers based on an unselfish attitude toward their workmen, and with the greatest possible latitude for the exercise of individual action by its members. Foremost among the objects of such an association should be not only to protect its members from the unjust demands of their workmen, but to insure justice to the workmen at the hands of its members. It is incumbent on the employers to set the example in this respect. We know that it frequently happens that although the sentiments of the most heavily interested employers toward their workmen are of the most kindly nature, there will arise misunderstandings, discontent, and sometimes open conflict. This occurs largely where the magnitude of a business is such that the employer cannot keep in touch with the feelings of his workmen and must depend on subordinate officials for the maintenance of cordial relations. It is under circumstances of this kind that the perversity of human nature clothed in that transparent cloak of gentility will sometimes manifest itself, resulting in losses the extent of which is seldom realized. While the burdens of large employers of labor are so great as to render their personal attention to details a physical impossibility, they are nevertheless responsible for the actions of their subordinates.

I believe that the nature of the average workman in America, and perhaps elsewhere, is such that when persistently approached in a conciliatory manner he can be reasoned with sufficiently to see and appreciate the fact that his interests are identical with those of his employer. In order to accomplish this desirable result it is imperative that his employer should voluntarily concede whatever he is justly entitled to, without waiting for the command of organized labor or the force of public opinion. If that had been done to a greater extent in the past it is possible that we might hear less of the arbitrary demands of organized labor now. Nevertheless it is a policy which will always be in order, and when backed by the power of united capital, which organized labor has made an absolute necessity, its influence for good will be felt throughout the whole industrial field. With united capital —that is, an employers' organization—organized labor will be more inclined to listen to reason. Courts will take courage and cease to shuffle with property rights, and will forever establish the fact that when an employer has satisfied all legal requirements he should be

protected in his right to manage his business according to his own best judgment and to market his product without fear of molestation. The effect of such ruling will in all probability drive labor into politics as a distinctive element. This emergency can be left to the consideration of our statesmen.

Labor, when organized to the extent to which it now aims, will hardly show sufficient prudence and toleration to command the confidence of business interests. For that reason organized capital sufficiently generous and wise to recognize the just rights of labor, and strong enough to resist its arrogance, is a necessity. Since we must have organization, the better both sides are equipped in that respect the less liability of strife, owing to fear of each other. Prudence is the child of fear. This principle is well demonstrated in international relations and it will hold equally well between smaller bodies, even down to the individual. We know that however well disposed labor leaders are toward law and order during strikes, they are incapable of preventing or suppressing lawlessness. In fact, if they were and did, they would not long remain leaders. The best evidence of this truth is the fact that we hear of no cases of punishment for this crime by the unions. For that reason, and in order to support those of its leaders who are kindly and fairly disposed, capital must present a solid front to organized labor. This is necessary in order to set them to thinking—thinking of the whole industrial situation instead of a portion of it. And while in that desirable frame of mind they may, instead of deciding to try conclusions with capital on that grand scale of which some of their misguided friends so flippantly talk, awake to this one wholesome truth, that under circumstances of that kind it is in the power of two or three capitalists to send a sufficient number of the financial institutions of the country tumbling in ruins to bring labor to its knees in a very few weeks. It would be well for employers to realize that also, in order to inspire them with sufficient courage to maintain their rights under the blessings of continued prosperity for which they so loudly called, rather than be talking of an industrial depression to help them resist what they consider the unjust demands of labor. While measures of this kind would be heroic they would probably be justified, notwithstanding the sacrifice, because we know that there are no great and lasting benefits without great sacrifices. The object, then, is to bring organized labor to its senses before that climax is reached—to get both sides in that conciliatory frame of mind wherein they can consider each other's contentions with a just appreciation of the power and resources which could be utilized

in the event of disagreement and conflict. Under a full realization of what this would mean, they would be likely to find some means by which differences could be amicably adjusted.

The most common method now in use is voluntary arbitration—compulsory being out of the question in America. That this method has given good results in most cases cannot be denied. It has settled disputes between labor and capital, thus giving motion to the wheels of commerce and industry, and anything that will accomplish that is commendable. But notwithstanding this, arbitration is, in my opinion, but a mere temporary expedient and does not go to the root of the trouble. What it produces is practically a forced settlement by the intervention of a third party. What is wanted is some means by which capital and labor can control their passions and prejudices sufficiently to settle their disputes without outside interference. This may call for an extraordinary control of human nature. Granted that it does. Nevertheless when we reflect on the fact that practically all that is best and noblest in this world is the product of voluntary human restraint, and that due to the teachings of individuals at one period or another of the world's history, we can see no reason why we cannot hope for a little more of mutual magnanimity between the two most potent forces controlling human happiness. To arbitrate practically means to compromise, and he whose demands are the most frequent is the greatest gainer. Rarely, if ever, will demands meet with complete refusal in a court of arbitration. For this reason it is singular that labor has been so slow in recognizing its advantage to their interest.

The settlement of wage questions by arbitration or through labor-union leaders would in time be productive of class distinction, because it destroys the opportunity for those close personal relations between the employer and the workman which the individual adjustment of remuneration makes necessary. As a result, I believe the tendency will be for the individual workman to look to his union and organized labor generally for all that he expects from his employer, no matter how well disposed the latter may feel toward him. This is just what organized capital should endeavor to prevent, because it is, fundamentally, a step in the wrong direction. It is reducing the all-important unit—the individual—to a mere cipher. It is also placing his destiny under the influence of a pernicious system of restriction. At the very outset of his career he meets apprenticeship and other rules that deprive him of rights guaranteed by the constitutional law of his country—the choice of such trade or profession as may be indicated by his natural inclinations, and the privilege of producing according

to his ambition and physical endurance. Such a policy is contrary to the best interests of all concerned. Idleness, forced or voluntary, during working hours is subversive of morals and manliness. The men whose names will live the longest are those who in life work the hardest. It does not require prophetic vision to discern that the trend of industrial evolution is in the direction of an intensity of effort—harder work in proportion to shorter hours; and when effort is up to the limit of human endurance, facilities, the product of the brain, will come to its aid. Shorter working hours with two or more shifts as local conditions require is what we are coming to. This policy will give far better results to the workman in the long run than restriction, but it is hard to make him see it and his employer has not the courage or foresight to prove it to him. If capital can be brought to see that this is a true principle of industrial economy and prepare for its advent, much saving will be effected and friction avoided.

But above and beyond all other principles should be the care and encouragement of the individual workman. His freedom of thought, action, and ambition along industrial lines should be the earnest solicitude of all employers of labor. By kind and generous treatment particularly in youth, he should be made to see that his interest is with his employer. His ambition should be gratified, and if latent, aroused. The fact that a workman does not personally force recognition of his merits is not sufficient evidence that he does not possess the necessary qualifications for an ambitious workman and faithful friend of his employer. That fertility of soil is not always reflected by surface indications is as true in human nature as it is in agriculture. The thing to do is to cultivate it by sowing the seed of ambition right down to that point where the youth in all his simplicity of mind and ignorance of his future steps upon the industrial field. Show him by the justice of your treatment and the strength of your resources that it is in your power to reward and protect him. You may not harvest all you cultivate, but you will enough to leaven the mass. The avidity with which the employees of the United States Steel Co. took up the stock set aside for them is an indication of the direction in which to move. Some day those large industrial combinations will add the "committee for the encouragement of the willing worker," and all that the title suggests, to their systems of committee management. They will find it a very important and profitable department.

In looking over the whole industrial situation there does not seem to be any cause for serious alarm among men of cool judgment, clear vision, with a just appreciation of their rights, and the courage of their convictions.

THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

By Fred. M. Kimball.

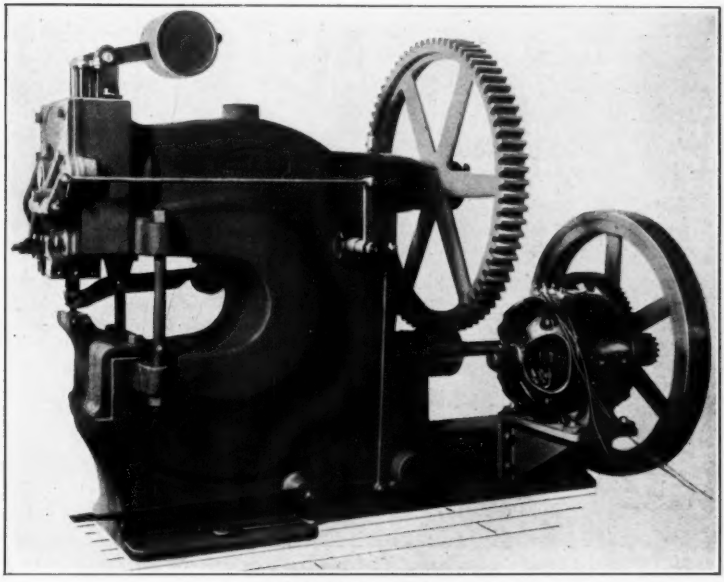
II —THE ELECTRIC MOTOR IN THE MACHINE SHOP.

In the series of articles which began in our April number, and of which this is the second, Mr. Kimball addresses himself to the questions which meet the factory owner or manager—"where and how will I economize by using electric drive, what points must I consider and what methods must I follow in installing motors, and what effects on shop practice and organization will follow?" While primarily related to the machine shop, the treatment will have wide application to all manufacturing industries. The June number will deal with "The Choice of Electric Motors."—THE EDITORS.

MECHANICAL engineers have long been aware of the great losses in the productive capacity of shops and tools through the wasteful distribution of power by shafting and belting, and also through the impossibility, by any speed-changing devices which were available, of keeping the machines up to their maximum production over a wide range of operation and on different classes of material. Hence, when once the utility and fitness of the electric motor as a means of distributing power had become apparent, and manufacturers had seen its possibilities in the way of speed variation, flexibility of application, economy of operation, and cheapness of maintenance, they were not slow to take up its use, tentatively, at least.

Printers, in particular, were eager to adopt the new method of operating their presses, and it is to the owners of large printing establishments that the opportunity of demonstrating the utility of the electric motor, and thus making it attractive to other users of machinery, is very largely due.

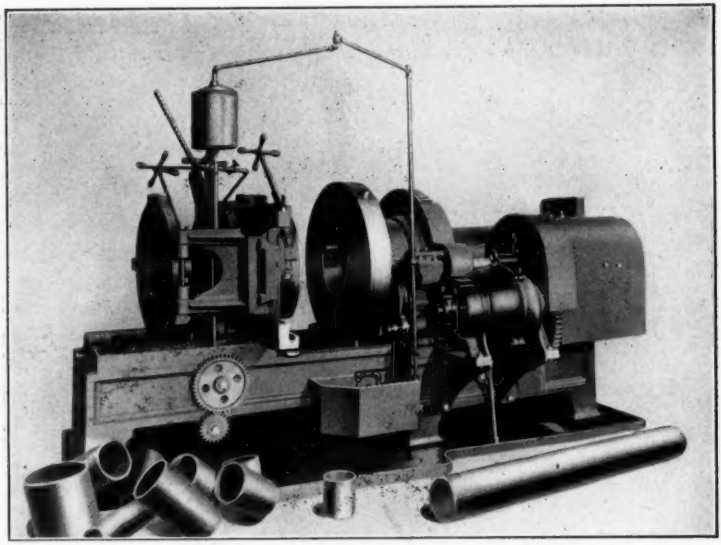
For a number of years after the first practically operative motors were installed, little was accomplished in the way of effective speed regulation—the use of the electric motor being principally confined to driving line shafts or the supplying of power to small manufacturers from central stations. Ere long, however, the possibilities of eliminating much of the head shafting, main shafting, and heavy belts in large manufacturing establishments, by means of sectional power distribution from electric motors, became so apparent that a considerable number of manufacturing companies were induced to put in electric



MOTOR-DRIVEN PUNCH.
Cleveland Punch & Shear Works Company; General Electric Motor.

generating plants and to distribute motive power therefrom to groups of machines located on the various floors and throughout the various buildings of the works.

The general results from all these undertakings were of the most satisfactory character and the demand for motors and accessories increased from year to year at an astonishing rate. Four or five years ago the demands for products of American manufacture began to expand to such an extent that it became necessary for factory managers to make a special and more vigorous study than ever before of the problem as to how they might increase the product of their various shops or factories without adding new machinery, taking the time to re-arrange their buildings, or building new ones. About the same time, experiments previously undertaken in producing better steel from which cutting tools might be made, began to bear fruit, and it was found, a little later, that by the use of the Taylor-White and other similar processes, tool steel might be manufactured which would allow a cut and feed of such magnitude as to increase very largely the amount of metal which could be removed from any work being machined during a given time. This meant the possibility of enormous



SAUNDERS PIPE-CUTTING AND THREADING MACHINE GEARED TO SPRAGUE ELECTRIC COMPANY'S MOTOR.

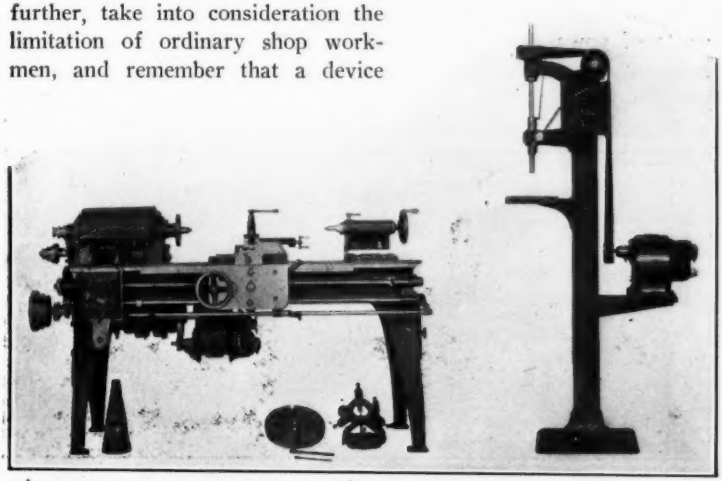
savings through increased production from the same floor space and tools and under practically no greater fixed charges. Concurrent with the advance in this direction, came an investigation of the possibility of better speed control for machine tools, whereby the cutting speeds might always be kept up to the maximum through an exceedingly wide range of work and the cutting tools pushed to the highest possible duty. No system of belts or other mechanical power transmission available has alone been found adequate to meet the possibilities in this direction which may be realized through the use of variable-speed motors.

There is a very wide difference of opinion between the manufacturers of machine tools, the proprietors of shops, and the workmen whom one interviews, as to how great a range of speed is really necessary with a given tool, within how fine increments of speed variation it is necessary to bring the speed control, and whether all of the control should be mechanical, all of the control electrical, or a part electrical and a part mechanical. On the one hand, we find some authorities asserting that a comparatively small range of speed control in the motor driving any given machine is all that is necessary; these people feel that the coarser steps, at least, in speed variation may bet-

ter be accomplished with change gears, or their equivalents. On the other hand, extremists, especially among some motor builders, maintain with great tenacity that the range should be wide and all produced in the motor itself. Good arguments are advanced to maintain the position taken by the adherents of either system.

Consulting engineers, owners of shops, and manufacturers of motors also differ in regard to the degree to which the subdivision of driving should be carried in the equipment of the machinery in any manufacturing establishment with motors. On the one hand, some engineers and manufacturers advocate the equipment of every machine tool with a separate motor, while others advocate the use of a few motors, of comparatively large size, each driving a moderately long distributing shaft which may supply power to the whole floor or a part of the floor. Here, too, there are good arguments to be advanced in support of either position, but undoubtedly the best practice will ultimately be found to lie midway between the extremes.

The art of motor design and construction has progressed to that point today when, from a purely technical standpoint, almost any problem in motor application may be readily solved and a suitable motor designed and built, which will produce the required results. But as engineers in the broadest and latter-day sense, we must all consider the commercial side; and we must, further, take into consideration the limitation of ordinary shop workmen, and remember that a device

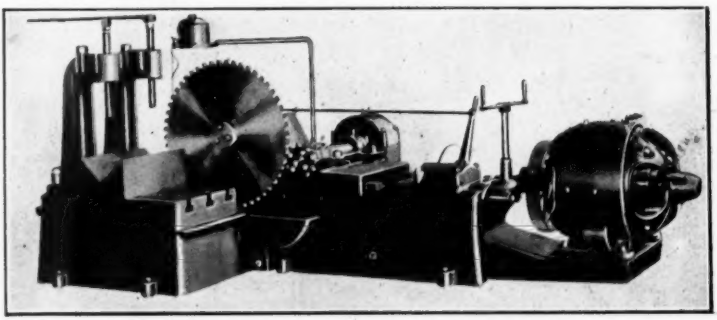


16-INCH PRENTICE LATHE DRIVEN BY ¾-HORSE-POWER MOTOR, AND SINGLE-SPINDLE DRILL DRIVEN BY ¼-HORSE-POWER MOTOR.
An interesting example of individual drive by very small motors. General Electric Co.

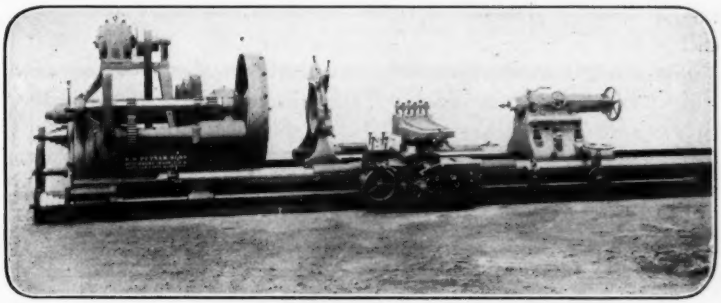
may lose the major portion of its utility—no matter how perfectly designed or excellently built—if it is not handled as it was made to be handled, and if good judgment is not used in its operation. It seems, therefore, at the outset, that one leading feature of any system of electric driving which we may put into a machine shop or factory must, as a *sine qua non,* be its comparative simplicity in construction and operation, and that it shall not necessitate the exercise of a greater degree of knowledge and manipulative ability on the part of the user than he is required to exercise in turning out the work or performing the operation for which the tool or machine as a whole is designed. In other words, we must remember that, if the workmen who are using this apparatus possessed the knowledge and qualifications to enable them to handle it as intelligently as those who designed it, they would undoubtedly be filling other and more advanced positions.

Repeated experiments, carried on at different times and in different manufacturing establishments, by competent investigators, have conclusively shown that the efficiency of power distribution in general rarely rises above 65 per cent., and often does not reach over 30 per cent.; that is to say, in the case of a factory receiving its motive power from an engine, the amount of power wasted in belting, shafting, mules, counters, gears, etc., ranges from 35 per cent. to 70 per cent. of the capacity of the engine.

It has been estimated by very careful engineers, that owing to this waste of power and lack of proper speed control, and outside of factories where special work only is done and special machines are provided for doing it, the product turned out averages only 15 per cent. to 20 per cent. of what might be turned out under the most advan-



METAL-SAWING MACHINE DRIVEN BY 5-HORSE-POWER 250-VOLT SHUNT-WOUND MOTOR.
Railway Appliances Company and General Electric Company.



ELECTRIC-DRIVEN ENGINE LATHE.
Putnam Machine Company's standard lathe; Westinghouse 7½-horse-power alternating-current motor.

tageous methods of operation. These statements may be somewhat radical, but there seems to be but small doubt that not over 50 per cent. or 60 per cent. of the work is turned out on the average in the general run of such establishments, which might be turned out were they operated under the best conditions commercially attainable.

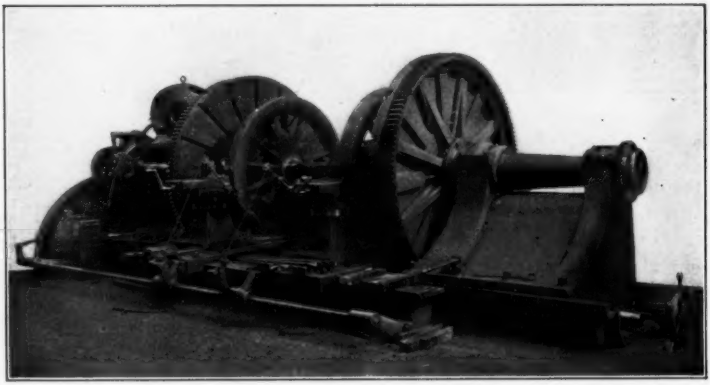
As an illustration of the loss of productive capacity in a machine tool carrying cutting edges, through the inability of the operator to regulate easily and maintain closely proper cutting speeds at any fixed rate, let us examine an ordinary engine lathe and endeavor to determine what proportion of the time such a machine may be operated at theoretically proper speed when driven in the ordinary way by belts and pulleys and operating on the variety of work which may come to it in an all-round shop.

Let us suppose that there are two equal cones of four steps each, the ratio of extreme speeds being as 40 is to 250; it will not be necessary for us to consider the back gears nor the possibility of doing any work which might necessitate their use, for they but extend the range of obtainable speeds and have little to do with the smallness of incremental speed changes possible. If these cones were not stepped at all but were simple truncated cones of revolution, there might be obtained, theoretically and by careful shifting of the driving belt, two hundred and nine intermediate, integral speeds from the lowest to highest, or two hundred and eleven speeds in all, each varying from the one above or below by one complete revolution of the live spindle.

Let us further suppose that, beginning with the lowest step, a series of changes be chosen as representing the theoretically desirable standard speeds such that each shall vary from that above or below by not more than 2½ per cent. either way; that is, we divide the total possible

number of integral speeds into such a number of working speeds that each differs from the other by not more than 5 per cent.

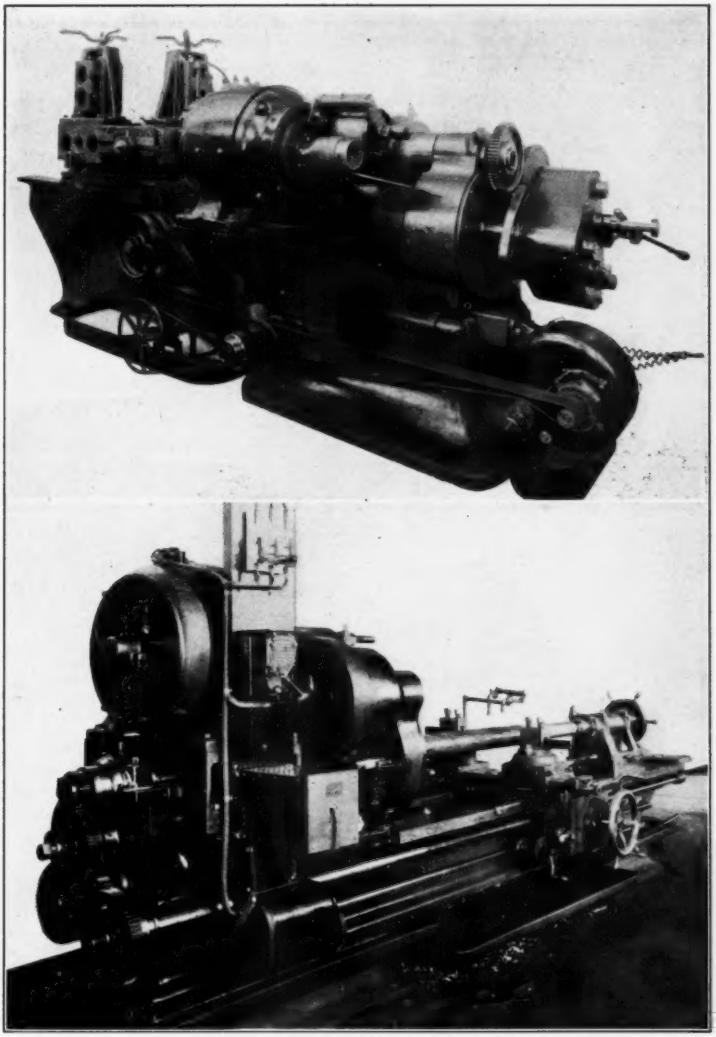
Assuming that the variation of 2½ per cent. either fast or slow will make no appreciable difference in the life of the cutting edge, or the product of the tool, and that such increments fulfill all reasonable commercial requirements of the most finical advocates of minute speed control—then under these conditions, it would be desirable to



15-HORSE-POWER CROCKER-WHEELER MOTOR DRIVING AN 84-INCH NILES DRIVING-WHEEL LATHE, L. S. & M. S. RAILWAY SHOPS, COLLINWOOD, OHIO.

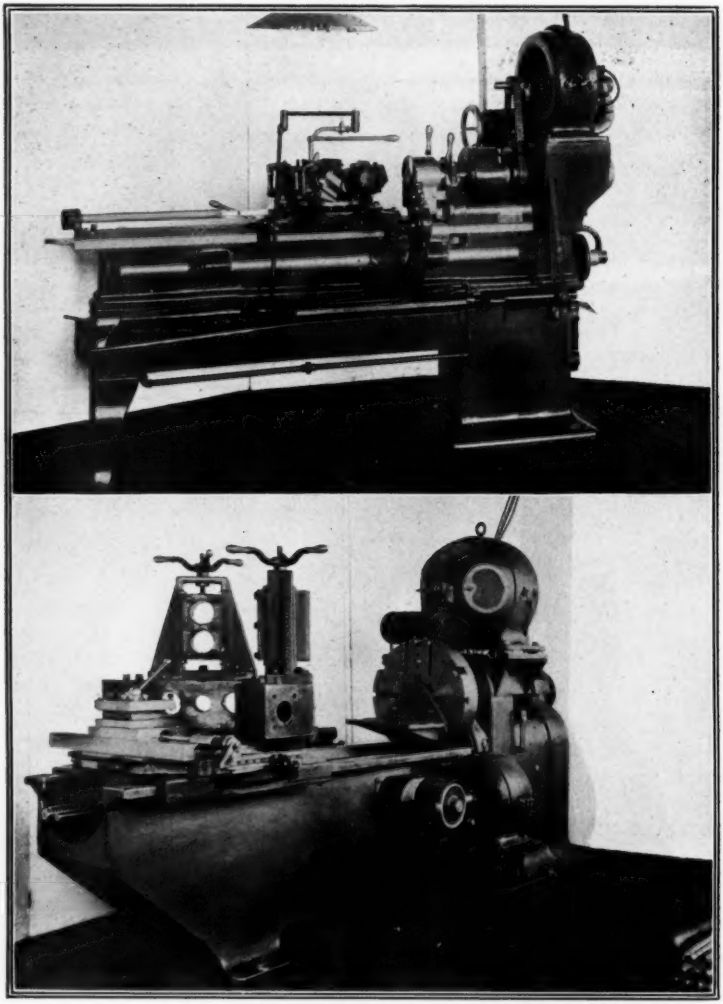
have a total of forty-two steps in our cones to enable us to obtain the best results and highest production.

As a matter of fact, there are but four steps in the cones we are considering and, consequently, in view of the varying work and stock that comes to our all-round lathe, we can maintain theoretically proper speeds only four times out of forty-two; or, which is the same thing, about one-tenth of the time, or one hour out of every ten. Nine-tenths of the time our speed requirements will either be too fast or too slow to be met by any one of the four steps. We may fairly assume that one-half of this time the next smaller driven cone would give us a faster speed than we need for the work in hand, and that the other half of the time the next larger driven cone would give us a slower speed than we desire. We cannot avail ourselves of the small cone in the first case, anyway, for the tool would not hold its edge; and in the second case, we must go to the larger cone for the same reason, although the speed will be lower than we might profitably use. In either of these events, we do not get the highest speed suitable to the work in hand and must run nine-tenths of the time at speed averaging



LATHES OPERATED BY ELECTRIC MOTORS.

Above is a turret lathe made by the American Turret Lathe Co., of Wilmington, Del., operated by a 3-horse-power and a 1-horse-power motor; below is a 26-inch Bullard roughing lathe operated by a 10-horse-power 250-volt motor. The electric equipment in both cases is by the General Electric Co.

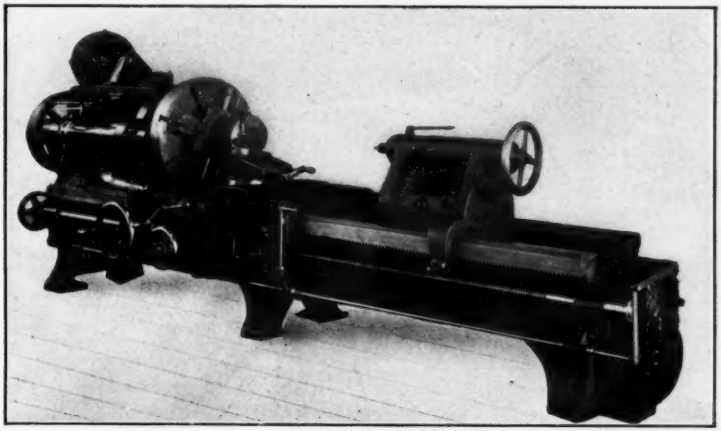


MOTOR APPLICATIONS TO LATHE DRIVING.

Above is a Jones & Lamson turret lathe, with 5-horse-power motor, multiple-voltage speed control; below is a Conradson lathe made by the American Turret Lathe Co. and driven by two motors—a 10-horse-power on the spindle and 3-horse-power on the feed, using multiple-voltage speed control. Both examples are from the Crocker-Wheeler shops and show Crocker-Wheeler equipment.

about one-half those which we might most advantageously employ. Making all reasonable allowances, we shall not be far out of the way in asserting, under these circumstances, that the engine lathe in an ordinary shop, used on all-round work, does not turn out much more than 60 per cent. of what it might otherwise do, were it provided with an efficient and easily manipulated means of changing speed by comparatively small increments and over wide ranges.

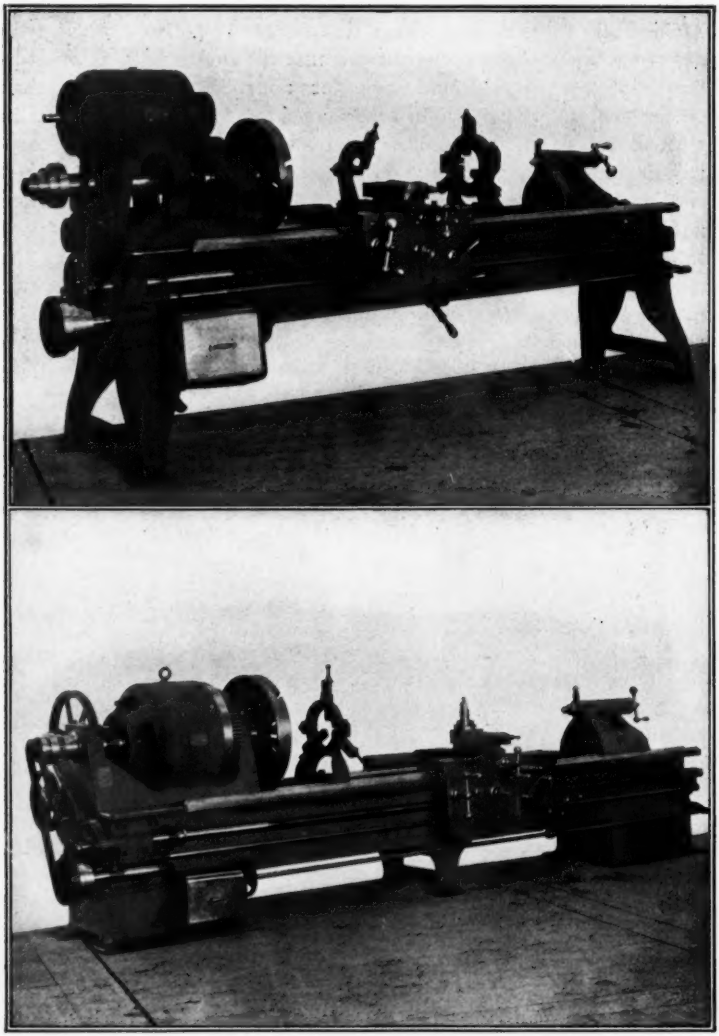
Cone pulleys with forty-two steps are manifestly impractical and even if we had them, it is doubtful if workmen could be induced to shift their driving belts as often as they ought. In any event the attention and labor involved would be prohibitive. An electric motor may be arranged, however, to give large variations of speed control by very slight increments, and the labor and attention of the workmen needed to effect and follow these changes is trivial. The controlling apparatus may be governed by a handle or handles carried on the



28-INCH LATHE DRIVEN BY 3-HORSE-POWER DIRECT-CURRENT MOTOR.
Variable speed control, the controller being operated from the carriage so the operator's eye need not be taken from the chip. Northern Electrical Mfg. Co. and Pond Machine Tool Co.

apron of the lathe and where they may be manipulated without the necessity of the workman taking his eyes from the chip he is cutting.

As the quantity of work performed on such a machine tool is largely proportioned to its cutting speed, it is quite possible by the use of motor-driven tools with good variable speed control, to reduce the losses mentioned very materially and thus largely to increase the product with substantially the same fixed charges. The practical extent

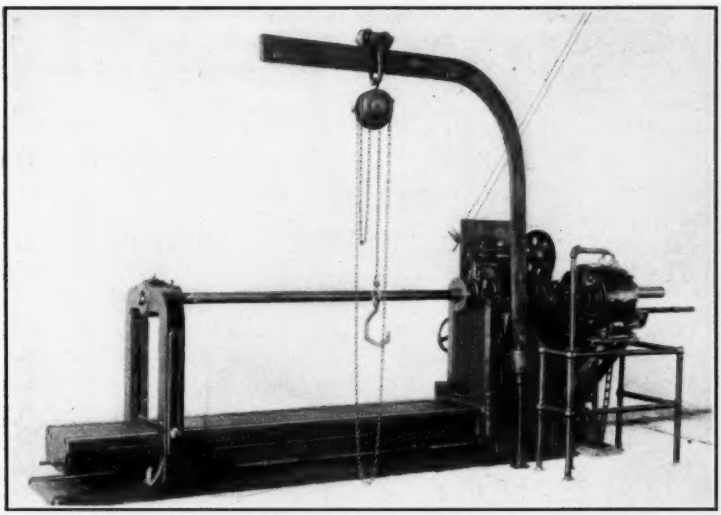


ABOVE IS A 14-INCH LE BLOND LATHE AND BELOW A LATHE BY SCHUMACHER AND BOYÉ, BOTH DRIVEN BY DIRECT-CURRENT MOTORS.

Bullock Electric Mfg. Co., Cincinnati, Ohio.

to which these losses may be reduced or the product increased depends after all, however, upon the local conditions obtaining in each shop and, to an almost equal extent, on the man who attends the machine, the care with which he adjusts his speeds and cuts, and his conscientiousness in keeping them regulated to the work in hand from time to time.

We have considered the speed requirements of the lathe at some considerable length for the reason that they vary so widely and present

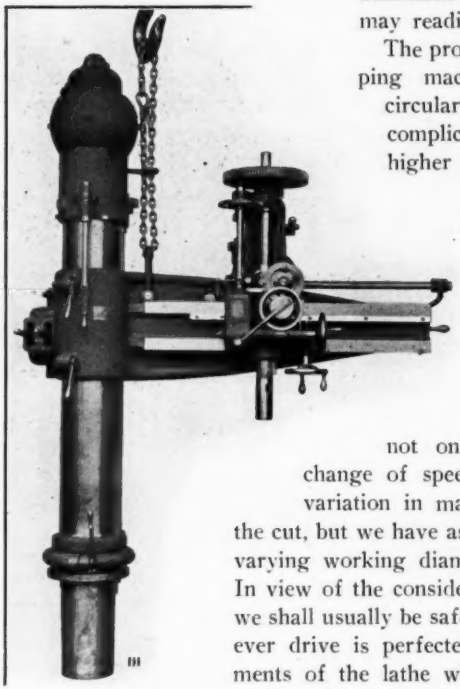


HORIZONTAL BORING MILL DIRECT-CONNECTED TO 5-HORSE-POWER MOTOR.
Binsse & Hauschild, Newark, N. J.; General Electric Motor.

one of the most difficult problems to be met in the equipment of machine tools with electric drive.

Boring mills and drills entail similar difficulties in the selection of equipment, although not usually to the extent of those encountered in the consideration of lathe requirements. Stated roughly and in general, grinding machines of nearly all sorts necessitate variable speed control in the proportion of one to two or higher. That is to say, if a grinding machine is to produce its highest output, a speed control must be readily obtainable, not only to correspond with the quality of the wheel used and the work on which it is used, but sufficient to compensate for the wear in the diameter of the wheel. It is very important that the periphery of the grinding wheel should be kept at the maximum cutting speed at all times. Cutting-off machines for operating on pipe,

merchant bar, and stock sizes in machinery steel, iron, and shafting, ought to be provided with variable-speed motors. This problem has already been worked out in a very satisfactory manner in several cases, and the time required to cut off a 4-inch shaft, for instance, when an automatic electric control is used, may readily be reduced one half.



BICKFORD RADIAL DRILL DRIVEN BY 5-HORSE-POWER NORTHERN DIRECT-CURRENT MOTOR.

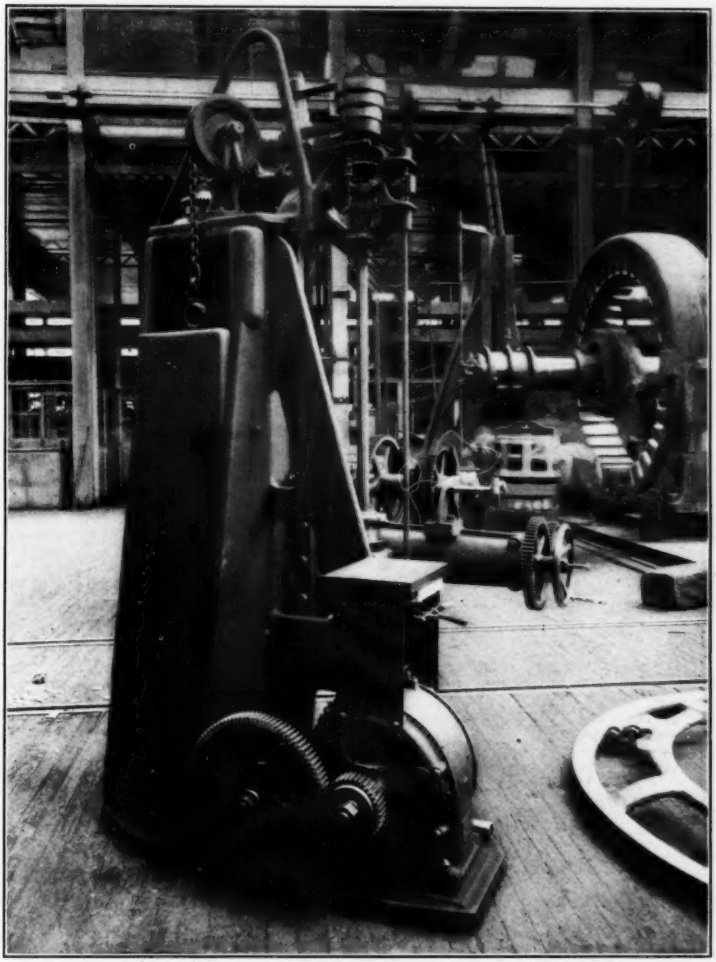
Carried to work by crane. Shops of Dodge Mfg. Co.

The problems involved in equipping machines which effect a circular cut are in general more complicated and require a higher range of speed control than in the case of those machines which operate with a simple rectilinear motion.

In the case of machine tools running a circular or spiral cut, we have not only to provide for the change of speed required to suit the variation in material and character of the cut, but we have as well to provide for the varying working diameters of the tool path. In view of the considerations set forth above, we shall usually be safe in asserting that whatever drive is perfected to meet the requirements of the lathe will often, in a modified and simplified form, meet the requirements of other machine tools employing rotary movement.

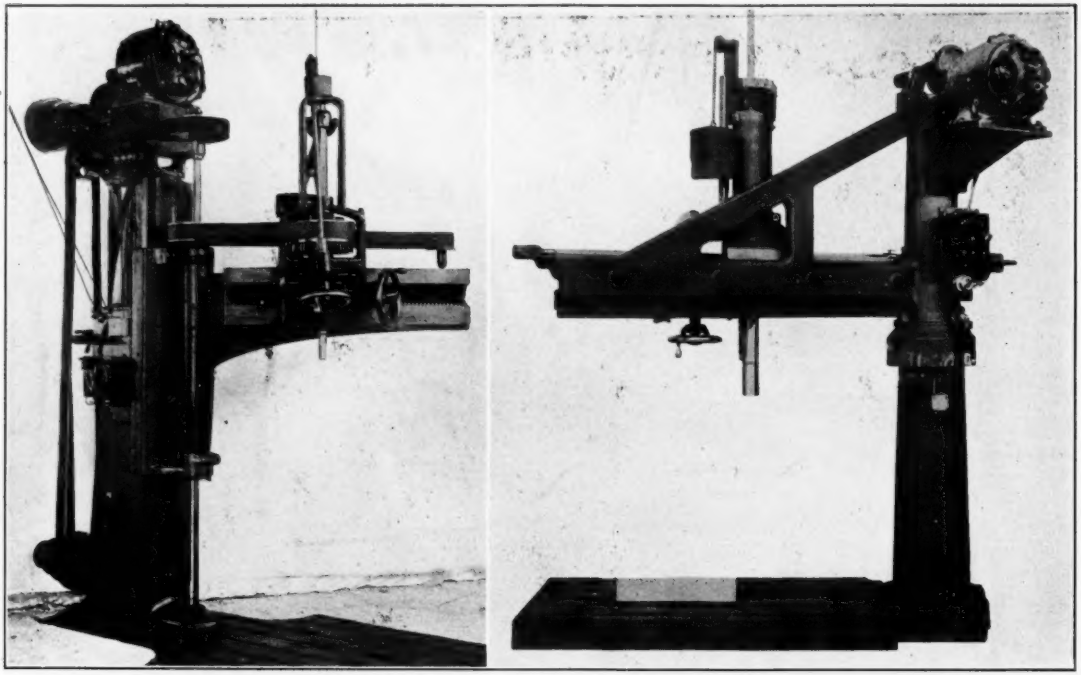
The problem of equipping such machines as planers, key seaters, slotters, and shapers, is in many respects much simpler. Here we rarely have any requirements for speed change, except to meet the needs of cut or material. It is rarely necessary to vary the rate of cut while working on any given surface.

The principle of providing heavily built tools and driving them at their full capacity having been pretty well established, it is interesting to note where the savings lie. Irrespective of increased cost of tools



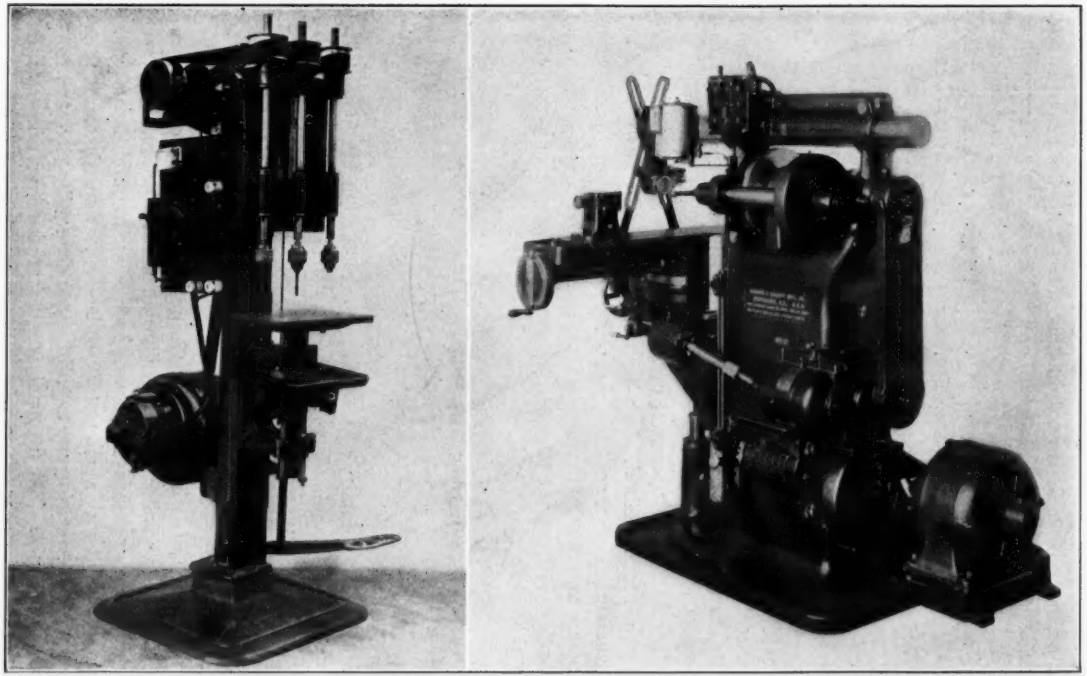
ELECTRIC-DRIVEN PORTABLE MILLING, DRILLING, AND BORING MACHINE.
Driven by Westinghouse alternating-current motor and installed in the works of the Westinghouse Electric & Mfg. Co., East Pittsburg.

and equipment, on which of course a somewhat larger interest charge must be carried, a concrete case will work out something like this: assuming that a shop had a large quantity of steel shafting to rough out, running from 4 to 6 inches in diameter; if an ordinary 26-inch lathe was employed to machine these shafts, a chip 3/16 inch by 1/24 inch



THE ELECTRIC MOTOR APPLIED TO DRILLING MACHINERY.

On the left is a Pond Machine Tool Company's radial drill belted to 3-horse-power shunt motor. On the right is a radial drill by Prentice Bros., of Worcester, with 2-horse-power slow-speed motor. General Electric Co.



ELECTRICALLY OPERATED MACHINE TOOLS.

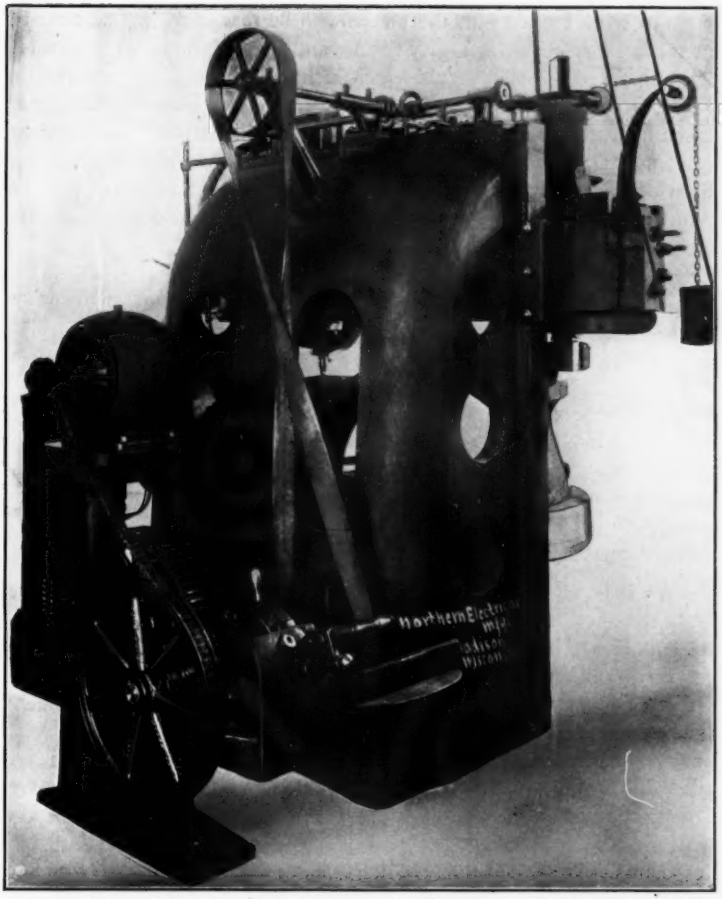
On the left is a Garvin three-spindle drill press, operated by a 2-horse-power 500-volt motor. On the right is a Brown & Sharpe universal milling machine driven by a 2-horse-power alternating-current motor. General Electric equipment.

removed at the rate of 30 feet a minute would perhaps represent the average of ordinary shop practice, and one and one-half horse power would probably be sufficient to pull this cut. With the heavy lathes now made and proper tools, we shall find it quite possible to run with a chip 1/4 inch by 1/12 inch at 120 feet a minute or more, and this will require about fifteen horse power. It will be observed that the ratio of metal removed in a given time, as between the first and second cases, is better than one to ten. Suppose the workmen to be paid 25 cents an hour in either case, then the labor expense of removing a certain quantity of metal would be, in the first case, $2.50, and in the second case, 25 cents. Assuming that the charge for current was 4½ cents per horse-power hour, the cost of power with the light chip would be 68 cents ($1\frac{1}{2} \times 10 \times 4\frac{1}{2} = 68$) and in the second case with the heavy chip 68 cents also ($15 \times 1 \times 4\frac{1}{2} = 68$). Assuming again, to complete the illustration, that the indirect expense of this shop was equivalent to 50 per cent. on its labor pay-roll, we have then, exclusive of power, a cost for the operation of $3.75 by the old method, and 38 cents by the newer method. In other words, the total charge would be $4.43 when much labor and little power was employed, and $1.06 when more power and less labor was employed—a difference in favor of the more modern method of $3.37, exclusive of interest and similar charges on the more expensive tool.

It may be objected by some reader that the data from which these comparisons are made are erroneous and therefore the conclusions worthless. I can only state that I have repeatedly seen work being done in the first way during years past, and during recent years quite frequently, I am glad to say, in the second way.

The apparent necessity of equipping the major portion of the machinery in a shop with electrical appartus capable in itself of producing extreme ranges of speed control, may be found when examined carefully to indicate a poor selection of machine tools or tools not properly adapted to the work in hand. For instance, the necessity of a very wide range of control in a boring mill might perhaps indicate either a shortage of lathe equipment, injudicious selection of sizes, or the need of other smaller and lighter boring mills.

It might be more advisable in some such a case to purchase an extra lathe or small mill with a one-to-two or one-to-four speed change than to attempt a one-to-six or one-to-eight speed change by electrical control on a large mill. The financial aspect from an investment standpoint might be far more favorable in many cases to the purchase of another comparatively simple tool than to tying up the considerable



5-HORSE-POWER NORTHERN MOTOR DRIVING A 51-INCH NILES BORING MILL THROUGH RENOLD SILENT CHAIN.

investment in the larger tool with its complicated and expensive speed-changing equipment, in order to meet the requirements of some line of small work. Each case of this nature, however, must be decided on its merits.

The question is frequently asked: "What power will be required to operate such and such a machine tool?" This question can not be answered in as off-hand a way as it is usually put. The power will vary with the design of the tool, the care with which it is kept up, the

class of work turned out, the material to be machined, the amount of metal to be removed in a given time, and the workman who operates it. I know of no reliable rule which includes the variables referred to. Each case must be considered by itself. A few general statements meeting average conditions may perhaps be hazarded, but if heavy tools and air-hardened steels are used and production pushed to the limit of the tools, from two to three or four times this power may be required. The rate at which the work may be pushed depends largely on the construction and rigidity of the tool.

Lathes.

22 in. to 24 in.	2-horse-power motor
30 in. to 36 in.	3 " " "
48 in. to 54 in.	5 " " "
60 in. to 72 in.	7½ " " "

Boring Mills.

48-inch swing	5-horse-power motor
72-inch "	7½ " " "
96-inch "	10 " " "
16-feet "	15 " " "

Planers, Single Head.

26 by 26	5-horse-power motor

Planers, Double Head.

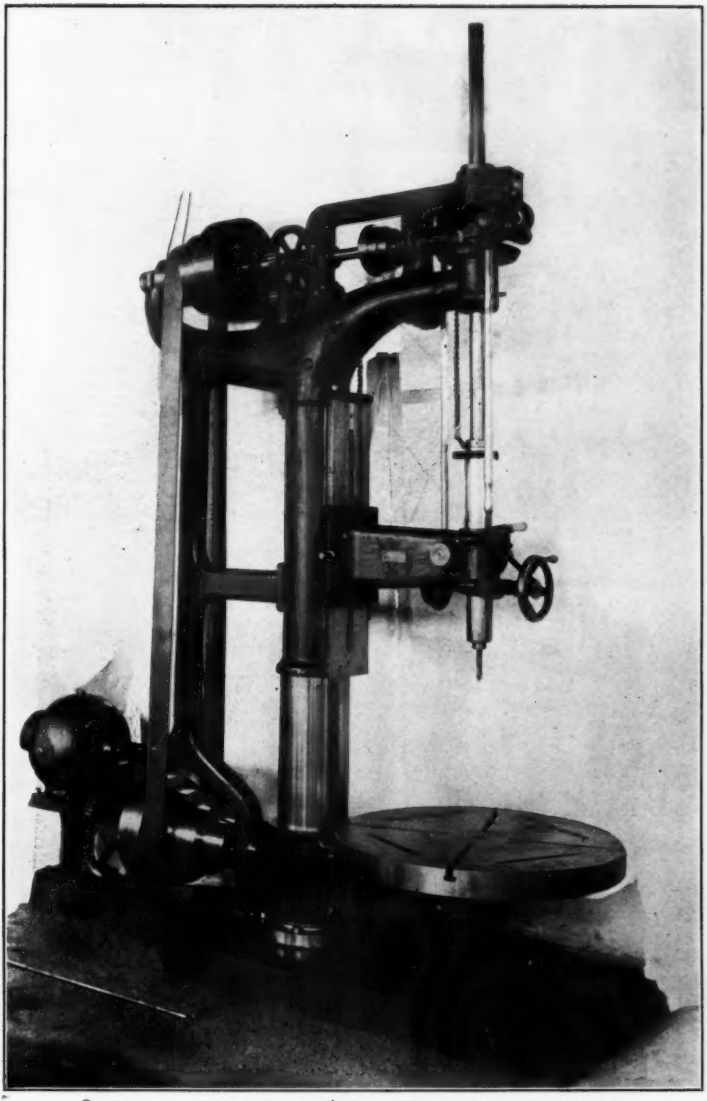
30 by 30 to 36 by 36	10 " " "
48 by 48 to 54 by 54	15 " " "
60 by 60	20 " " "

Drill Presses.

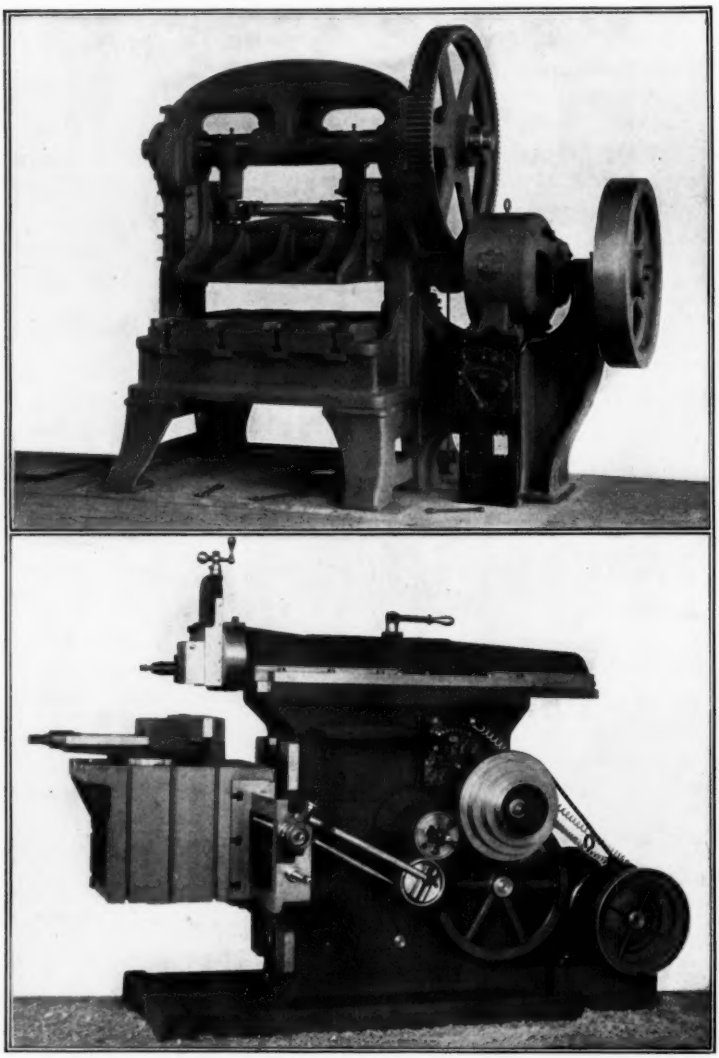
20 inch to 24 inch	2-horse-power
36 inch to 40 inch	3 " "
50 inch to 60 inch	5 " "

We may again emphasize as a leading principle that it is of the highest importance in equipping machine tools with motors, to avoid the adoption of any apparatus which will oblige the workman to assume for its proper operation any material addition to the mental or manual effort which he is already called on to exercise in the purely mechanical operation before him; that is to say if, in order to produce speed changes or variations of speed, a workman must undertake either laborious mental or physical exertion or the exercise of concentrated attention to attain the desired results, then one of two things will happen; either, from divided attention, the quality of his product will suffer, or, what is more likely, he will not use his equipment to the best advantage and the quantity of the product will suffer; and in either case the proprietor will not receive due benefit from his investment.

It is, therefore, absolutely essential that all the driving apparatus and mechanisms connected therewith be of the simplest design consistent with the results to be obtained, and that changes of speed be controlled through the simplest operations and by some device which may be manipulated preferably with one hand, without the workman being obliged to change his position, without the exercise of sensible labor, and without obliging him to divert his attention and eyes from the chip he is removing; hence, systems requiring a multiplicity of



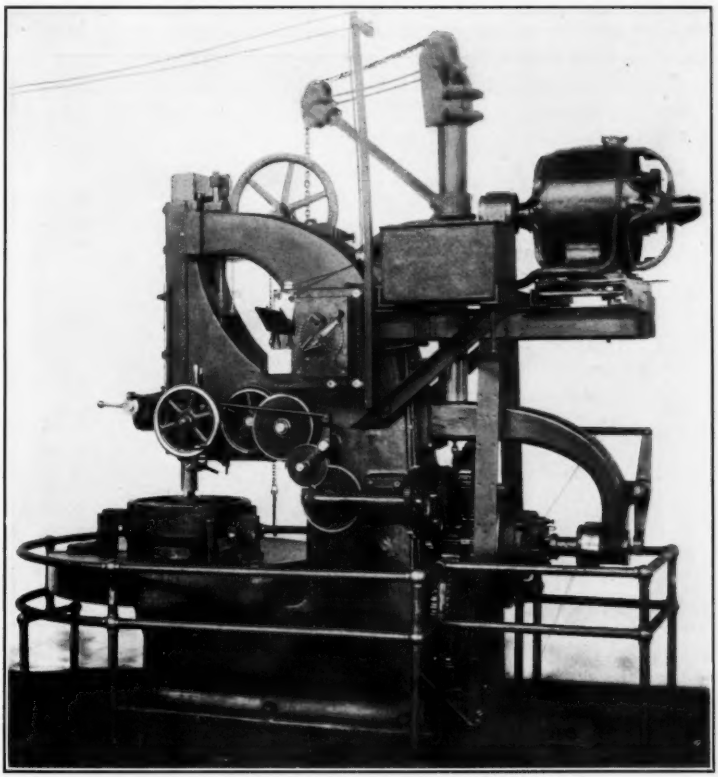
48-INCH DRILL DRIVEN BY 5-HORSE-POWER DIRECT-CURRENT MOTOR.
Cincinnati Machine Tool Co. and Northern Electrical Mfg. Co.



THE UPPER FIGURE SHOWS A BLANKING PRESS BY THE TOLEDO MACHINE AND TOOL CO., THE LOWER A SHAPER BY THE CINCINNATI MACHINE TOOL CO., BOTH DRIVEN BY BULLOCK MOTORS.

switches or manipulating handles, seem destined to fail in practical operation ultimately.

The expense of equipment must also be borne in mind continually, for equipment adds to capital account, and increased capital account means increased interest charges; and usually the more expensive



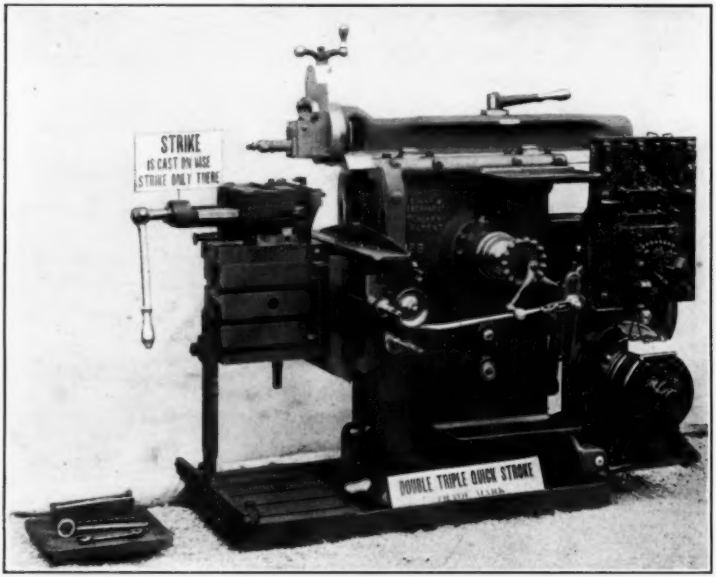
SELLERS BORING MILL DRIVEN BY 7½-HORSE-POWER GENERAL ELECTRIC MOTOR.

the apparatus, the more complicated it is and, consequently, the greater the continuous cost of its up-keep.

For all-electric control, a motor may be readily built and operated on the multi-voltage system with four or more wires, having several hundred per cent. in speed range; but this means the installation of a much larger machine and, consequently, a much more expensive machine than would be required, were only a moderate portion of the

control electrical and the remainder mechanical. Again, with such apparatus the cost of providing current supply, wiring, and controllers, is greatly increased.

There are, undoubtedly, circumstances where the installation of such apparatus is justifiable, but the greater number of ordinary cases may perhaps be better served by a control partially electrical and partially mechanical, or electro-mechanical. We can easily build a

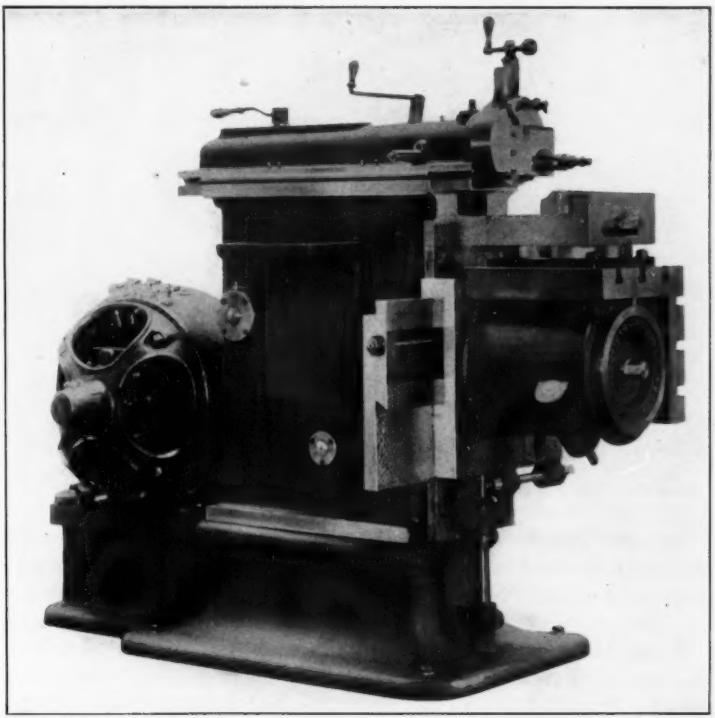


EBERHARDT SHAPER WITH DIRECT-CONNECTED SPRAGUE MOTOR, 3-HORSE-POWER.

motor to be operated on the two-wire system with a speed range of one to two by field control that will not be excessive in weight or expensive in price, and this same motor on the three-wire system may have a range of one to four; and my preference is generally toward the use of motors in which greater speed ranges than this are not attempted, everything taken into consideration.

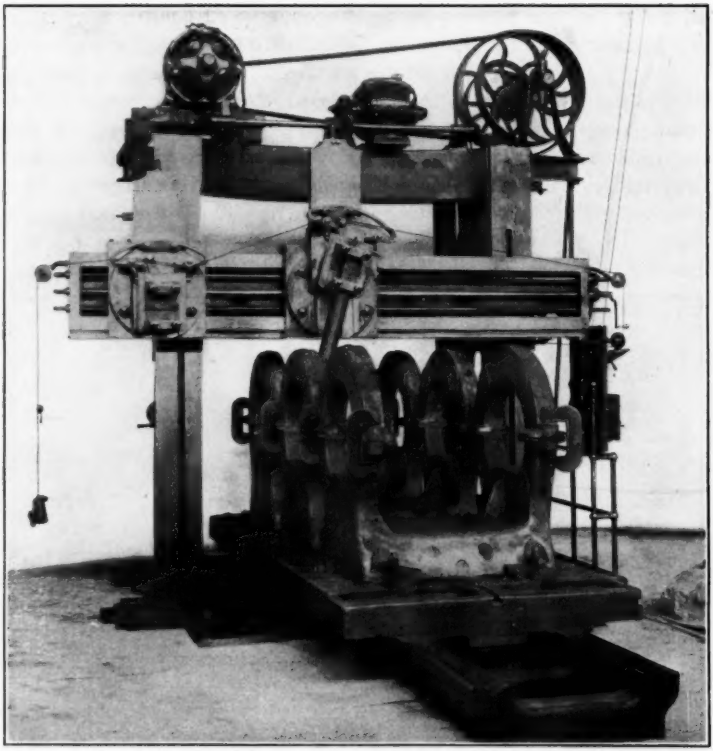
Large steps in speed change may be well taken care of mechanically, either by gears, short belts and cones, or rarely by friction drives, and the changes and variations from and between one of these steps to another may be accomplished by the motor. In the majority of cases, these coarser speed changes may be made manually without seriously diminishing the efficiency of the tool, for it is quite rare that

anything like the whole possible range of speed control is ever required during any one operation. With such mechanical changes and a motor possessing speed ranges of one to two, or one to four, to fill in the gaps between the mechanical changes, very satisfactory results are possible and at reasonable cost. It is a comparatively easy matter for a workman, when going into a new job, to arrange mechanically for the average speed required; afterwards, and during the operation to be performed, his motor will give him all the variation usually needed. No thoroughly satisfactory method of effecting the coarse mechanical speed changes previously alluded to through electrical control



POTTER & JOHNSON SHAPER DRIVEN BY 3-HORSE-POWER GENERAL ELECTRIC MOTOR.

is known to me as being in commercial operation at the present time. Systems comprehending this idea are being worked out, however, and when completed will largely simplify the problems now before us. With coarse mechanical speed steps electrically governed and thrown in and out in proper sequence with the finer speed changes obtained



84-INCH PLANER, WITH 3-HORSE-POWER SHUNT MOTOR FOR RAISING AND LOWERING CROSS RAIL AND 7½-HORSE-POWER COMPOUND-WOUND MOTOR BELTED TO BED PLATE.
Pond Machine Tool Co. and General Electric Co.

in the motor, all accomplished by one easily manipulated controller, we shall have attained a system which gives promise of being superior to anything now in use.

There is an economic side to this whole question which we may well touch on at this point. It is an element of human nature to desire to share any benefits which one is instrumental in obtaining for another, and I believe that nothing would make for better results in causing machine tools to be handled intelligently and kept at their highest point of productive efficiency than to introduce more widely in shops and factories some method of profit sharing whereby the workman might receive a sensible reward proportioned to the exercise of extraordinary care, judgment, and faithfulness in his endeavor to obtain the maximum quantity of perfect work.

A PRACTICAL SYSTEM OF MINE ACCOUNTING.

By E. Jacobs.

Mr. Jacob's article in our preceding number formulated the general principles which must be followed out in any comprehensive and efficient system of mine accounts. The paper now presented gives a brief, concrete example of a plan in actual use. It has the same definite, practical character as the series on shop accounts lately closed in THE ENGINEERING MAGAZINE.—THE EDITORS.

OLLOWING last month's review of "The General Principles of Mine Accounting," a brief outline will now be given of a system of mine accounting or cost keeping in use at several mines in British Columbia, and stated to have been obtained from offices of important mines in the United States. This summary, however, must be prefaced by an admission that it has been found difficult to convey in writing, within reasonable space limits, an adequate idea of any such system. But since a few weeks' practical experience of its working, or even an examination of books and forms when in use in carrying it out, is not practicable to the great majority of readers, the best must be made of the position.

Nearly all the examples of arrangement and rulings of books and forms here given are taken from those in use at the Le Roi and Le Roi No. 2 mines at Rossland, British Columbia. The accompanying information, though, does not necessarily follow closely in all details the methods employed in the offices of those mines, although their principal features are observed. A similar system, with some variations, is in force at other mines at Rossland, and as well at the Snowshoe mine in the Boundary District of British Columbia.

It is claimed for this system (in connection with which daily reports from shift bosses, foremen, mechanics, time keepers, store keepers, and others required to furnish information relative to either labor or supplies, are obtained and carefully checked and recorded), that it secures accurate returns of the men's time and the materials or supplies used, checks the time of every man employed in or about the mine, and supplies data for a daily tabulated report to the manager, which, though in condensed form, gives him sufficient information for the

LE ROI No. 2, LIMITED.

SHAFT DAILY LABOR REPORT.

NOTE on the back of this report the names of any new men; also men who do not work a full shift.

_____ MINE 11-7 O'CLOCK SHIFT _____ 190

NO. MEN	HOURS	MINUTES	OCCUPIED BY	SUNDRIES
			DRILLING	STICKS POWDER USED
			BLASTING	FEET FUSE USED
			SHOVELING	HOLES BLASTED
			TIMBERING	CARS HOISTED
			LOWERING PUMP	SETS TIMBER

PROGRESS OF SHAFT WAS DELAYED HOURS MINUTES, BY

SHIFT BOSS.

1. SHIFT BOSS'S DAILY REPORT, EXPLORATION OR DEVELOPMENT ACCOUNT.
Original is 6 by 4½ inches.

LE ROI No. 2, LIMITED.

ORE BREAKING DEPARTMENT _____ FT. LEVEL.

NOTE on the back of this report the names of any new men; also men who do not work a full shift.

SHIFT _____ 190

NO. OF FLOOR EAST	NO. OF FLOOR WEST	NO. OF MEN DRILLING	NO. OF MEN SHOVELING	TIMBER	TIMBER	TIMBER	NO. MACHINES	TOTAL NO. MEN

TOTAL OUTPUT ORE FROM STOPES _____

SHIFT BOSS

2. SHIFT BOSS'S DAILY REPORT, ORE-PRODUCTION ACCOUNT.
Original is 6¼ by 4½ inches in size.

most effective disposition of his working force and the consequent more economical management of the mine.

Several of the forms used in making the reports above referred to are reproduced herewith. Most of them are self-explanatory, and they will serve to indicate the nature of the information required from those whose duty it is to supply the particulars necessary for a systematic check upon labor and supplies. It will be noted that No. 1 is

West Le Roi Mining Company, Limited.

BLACKSMITHS' LABOR REPORT.

SHIFT _____ 190

OCCUPATION	No. MEN	RATE PER DAY		
FOREMAN BLACKSMITH,				No. Pieces Machine Steel Sharpened,
BLACKSMITHS,				No. Pieces Hand Steel Sharpened,
BLACKSMITH HELPERS,				No. Picks Sharpened,
SHARPENERS,				No. Pieces Machine Steel Made.
SHARPENERS HELPERS,				No. Pieces Hand Steel Made.
				No. Pieces Steel Returned Broken.
				Sacks Coal Used.

REMARKS.

HEAD BLACKSMITH

3. FOREMAN BLACKSMITH'S DAILY REPORT.
Original is 7 by 7 inches in size.

an example of the reports the shift bosses in the mine are required to furnish daily in connection with exploration or development work; No. 2 deals similarly with ore production; No. 3 is an example of the report a foreman mechanic has to send in; No. 4, not shown, is a powderman's daily report of the stocks of powder of each grade, the caps, and fuse used, designated by "level" and "place." In a measure, Nos.

RM. NO. 37—1-1902-300

NOTE. This form is to be filled in and forwarded to General Manager not later than 10 a.m. each day

LE ROI NO. 2, LIMITED.

EMPLOYED IN MINING OPERATIONS UNDER DATE,_____ 190__

WORKING	LEVEL	MORNING SHIFT							AFTERNOON SHIFT							NIGHT SHIFT							
		Drills Working	No. Cars	Machine Men	Shovelers	Trammers	Timbermen	Total Men for shift	Drills Working	No. Cars	Machine Men	Shovelers	Trammers	Timbermen	Total Men for shift	Drills Working	No. Cars	Machine Men	Shovelers	Trammers	Timbermen	Total Men for shift	Total Men for Day
TOTALS																							
Sup'l U'derg'd Emply's																							
FOREMAN																							
SHIFT BOSSES																							
POWDERMEN																							
TRACKMEN																							
CHUTEMEN																							
NIPPERS																							
SKIP TENDERS (NEW SHAFT)																							
SKIP TENDERS (OLD SHAFT)																							
PIPEMEN																							
ENGINEERS																							
Total Emply'd U'derg'd																							

5. DAILY TABULATED REPORT TO MANAGER, UNDERGROUND ACCOUNT.
The original is 9 inches wide and 17 inches high, giving much more space for entries above the "Totals."

1, 2, and 3, besides showing the number of men at work and the time they worked, record work done and some of the stores used. Nos. 5 and 6 comprise the daily tabulated report to the manager, to whom it must be made by a fixed hour every morning. The former shows all labor, properly classified, employed in each separate underground working; also number of machine drills working and cars sent out. The latter gives all surface labor, also classified. No. 7 is a weekly labor report, embracing all labor employed at the mine, whether underground or on the surface, summarizing the daily reports and exhibiting the total cost of labor for the week, this last being especially useful for purpose of comparison. No. 8 is a copy of a leaf taken from one of the books kept by the time keeper, this being a monthly summary

of all development (or exploration) labor, compiled from the shift bosses' and other daily labor reports, such as Examples Nos. 1, 2 and 3. Among the remaining forms of report in use is a Mine-Machinery Installation Labor Report, which shows the number of men employed in installing machinery, rate of each man's pay per day, and nature of work performed. In connection with this there is, where of sufficient importance to warrant it, a report for each separate piece of machinery in course of installation at the mine. Two other reports that may be mentioned are, (1) a monthly ore-production report for each

FORM NO. 28—1-1902-500
SHEET NO. 2

LE ROI NO. 2, LIMITED.

SURFACE EMPLOYEES UNDER DATE. _____ 190____

PLACE	CLASS OF LABOR	Day Shift	Night Shift	TOTAL	PLACE	CLASS OF LABOR	Day Shift	Night Shift	TOTAL
Blacksmith Shop					Carpenter Shop				
	Blacksmiths					Foremen			
	Strikers					Carpenters			
						Sawyers			
Stables						Sawyers' Helpers			
	Teamsters					Laborers			
	Laborer					Yardmen			
Hoist Room					Compressor				
	Engineers					Engineers			
	Firemen								
Boiler Room									
Sorting Room									
	Foremen								
	Sorters								
	Carmen								
Surface Tram to Railway									
	Brakemen								
	Carmen to Tram								
	Loaders at Car								
	Tram's to Ore Bins								
	" to Waste Dump								
	Total					Total			
					TOTAL SURFACE EMPLOYEES				
					BROUGHT FORWARD UNDERGROUND DEPT. SHEET NO. 1				
					TOTAL EMPLOYED.				

6. DAILY TABULATED REPORT TO MANAGER, SURFACE ACCOUNT.

Original is 8½ by 14 inches, giving more space for entries as indicated by break shown near the foot.

individual stope, showing each day's record of number of shifts engaged in drilling, blasting, timbering, and shoveling, quantity of powder and fuse used, number of holes blasted and cars of rock hoisted, and (2), a daily diamond-drill report, giving details of work performed and the geology of the country drilled through. It may be added that at one mine using the system under notice books of 100 pages, each ruled and printed as example No. 9, are in use, these allotting a full

LE ROI No. 2, LIMITED.

WEEKLY MINE LABOR REPORT

Week Ending _____ 190

OCCUPATION	SHIFTS	RATE PER DAY	TOTAL	OCCUPATION	SHIFTS	RATE PER DAY	TOTAL
FOREMEN				SINKING MACHINEMEN			
SHIFT BOSSES				SHAFT TIMBERMEN			
HEAD TIMBERMEN				SHAFT HOISTMEN			
TIMBERMEN				DRIFTING MACHINEMEN, Ft. level			
TIMBERMEN				DRIFT SHOVELERS, FT. LEVEL			
MACHINE MEN BREAKING				DRIFTING MACHINEMEN, Ft. level			
MUCKER BOSSES				DRIFT SHOVELERS, FT. LEVEL			
SHOVELERS STOPE				CROSSCUTTING MACHINEMEN, FT. LEVEL			
POWDERMEN				CROSSCUTTING SHOVELERS, FT. LEVEL			
TRACKMEN				DEVELOPMENT TIMBERMEN			
PIPEMEN				DEVELOPMENT TIMBERMEN, HELPERS			
PUMPMEN				RAISING MACHINEMEN, FT. LEVEL			
LADDERMEN				TOTAL,			
SHOOTMAN							
SHOOTMAN HELPERS							
NIPPERS							
SHIP TENDERS							
SHIP TENDERS HELPERS							
BLACKSMITHS							
BLACKSMITHS							
BLACKSMITH HELPERS							
TOOL SHARPENERS							
TOOL SHARPENERS HELPERS							
ENGINEERS, COMPRESSOR							
FIREMEN, COMPRESSOR							
ENGINEERS, HOIST							
FIREMEN, HOIST							
MECHANICAL FOREMAN							
HEAD MACHINIST							
MACHINIST							
TRAMWAY							
TRAMWAY							
TRAMWAY							
NIGHTWATCHMAN							
HEAD CARPENTER							
CARPENTER FOREMAN							
CARPENTERS							
LABORERS							
TRIMMERS							
BOSS ORE BINS							
ORE SORTERS							
CARMEN							
TOTAL							

No. MACHINES SHIFTS ON	FT. LEVEL.	No. MACHINES SHIFTS ON	FT. LEVEL.
No. MACHINES SHIFTS ON	FT. LEVEL.	No. MACHINES SHIFTS ON	FT. LEVEL.
No. MACHINES SHIFTS ON	FT. LEVEL.	No. MACHINES SHIFTS ON	FT. LEVEL.
		No. MACHINE DRILLS SHARPENED.	

7. WEEKLY REPORT OF ALL LABOR EMPLOYED.
The original is 8 inches wide by 11½ inches high.

page to each man employed. They show the nature of the work done by each man the month through, and so admit of a monthly analysis of labor being made up in the mine office should this duty not be intrusted to a time keeper.

LE ROI No. 2, Limited

Summary of Development Labor at _____ Mine

Month of _____ 190

DATE	No. SHIFTS						Sticks Powder	Feet Fuse	Holes Blast'd	Cars Hoist'd	
	Drilling	Blasting	Timber	Shoveling							
1											
2											
3											
14											
15											
Totals											
Av. Per Foot											

8. TIME KEEPER'S MONTHLY SUMMARY OF EXPLORATION LABOR.

To simplify the engraving, the form is shown in single column only. The original is in double column, providing for 31 days, and the "totals" of course appear under 31 in the right hand column. Original is 8½ by 11½ inches.

What is known as the "voucher system" is employed in connection with this method of cost keeping. The form of voucher is that in general use. It has printed on its reverse or back the names of the accounts, divided and arranged in similar order to that appearing in the book of record designated the Grand Journal. It is a general, though not an universal, custom to require merchants and others to supply invoices in duplicate or triplicate, one copy being attached to the original voucher sent to the head office, one to the duplicate voucher kept on file in the mine office, and, sometimes, a third copy for the mine store keeper. Where the head office is distant from the mine it is usual to have all vouchers and payrolls made up and signed in duplicate, so that a complete record of, and receipts for, all expenditures may be on file at both head and mine offices.

The payroll is made out in the form in ordinary use, having columns ruled to meet the requirements of the mine. The labor charges it covers are apportioned to the various accounts concerned. It is treated as a voucher, entered in the grand journal as such, and its distribution narrated in necessary detail, as shown by specimen entry, Example No. 10. The total is a credit for the bank account, and the corresponding debit total is made up by the several debits charged to their respective accounts through their proper divisions of the grand journal.

The principal books in use are the ordinary double-entry journal and ledger, a cash journal arranged in a series of columns, a book known as the grand journal, and a trial-balance book. Another book, called a stores journal, is sometimes used as a subsidiary to the grand journal. The ordinary journal is used for every class of entry not coming under the headings of the grand journal. The use of the cash journal appears to be optional, cash being journalized where it is dispensed with. At the Le Roi, No. 2, the grand journal is regarded as the principal book of original entry, the ordinary journal being called the side journal, but at the Snowshoe the position is reversed, the ordinary journal being treated as the principal book of original entry and the grand journal as an auxiliary book. There are, of course, subsidiary books, each office having its own methods in keeping records of the many details that are finally condensed into the entries appearing in the main books. These are adapted to the particular requirements of each individual mine, as experience shall determine.

The grand journal is the voucher record book, and in it the principle of double entry is preserved all through. It is a large book, its folios being 18 inches in depth and 46 inches in width, or 23 inches for each page. It has a number of divisions and these are subdivided as required for the classification of expenditures. The accompanying example (No. 10) shows the arrangement of the accounts, divided and subdivided. The first money column contains the total of every voucher entered in the book and the grand total of all amounts shown in this column equals that of all other columns, first of the debits and next of the credits, in the record excepting those under the division "Distribution." Following the date column are the two headed Dr. and Cr., respectively, these columns showing the division numbers, for ready reference. The use of the "Particulars" column is shown by specimen entries, to which further reference will presently be made. Divisions Nos. 1 and 2 in the Le Roi accounts were used for entering stores and machine-work transactions that company had with

No._____

Name _____

DATE	EXPLORATION	ORE PRODUCTION	MINE GENERAL		OCCUPATION RATE $____ PER DAY LOCATION OF WORK
1					
2					
3					
29					
30					
31					
					Exploration @ $
					Ore Production @ $
					Mine General @ $
					@ $
					@ $
					TOTAL $

9. PAGE FROM SNOWSHOE COMPANY'S TIME BOOK.
Original is 4 inches wide by 9¼ high.

its parent company, the British America Corporation. The columns are retained (without the original headings) in the example here given with the object of preserving the Le Roi numbering of the other divisions, but they are otherwise utilized as shown. The first shows a Store General account, the debit column presenting a record of amounts payable for all stores purchased but not immediately used at

GRAND JOURNAL STATEMENT FOR THE MONTH ENDING _____ 190____

DATE 1903	DR.	CR.	PARTICULARS	INV. NO.	TOTAL TRANSACTIONS	1 STORES GENERAL DR	1 STORES GENERAL CR.	2 DR.	2 CR.	3 BANK OF MONTREAL DR.	3 BANK OF MONTREAL CR.	4 EXPLORATION LABOR DR.	4 EXPLORATION SUPPLIES EXPLOSIVES DR.	4 EXPLORATION SUPPLIES ILLUMINANT DR.	4 EXPLORATION SUPPLIES SUNDRIES DR.	5 ORE PRODUCTION LABOR DR.	5 ORE PRODUCTION SUPPLIES EXPLOSIVES DR.	5 ORE PRODUCTION SUPPLIES ILLUMINANT DR.	5 ORE PRODUCTION SUPPLIES SUNDRIES DR.	6 GENERAL EXPENSE DR.
1 Jan. 20	10		*Mine Equipment Supplies*	23																
2		3	*To Bank of Montreal*								80									
3			*A.B. Manfg. Co. \ Mine Ore' Co.*		80															
4																				
5																				
6 " 31	4		*Exploration Labor*	24								450								
7			*Shafting* 1,500,00																	
8			*Driving* 1,250,00																	
9			*Raising* 1,000,00																	
10			*Winzing* 750,00																	
11		3	*To Bank of Montreal*																	
12			*January, 1903, Payroll*		4500						4500									
13																				
14																				
15																				

GRAND JOURNAL STATEMENT FOR THE MONTH ENDING _____ 190____

7 POWER PLANT LABOR DR.	7 POWER PLANT SUPPLIES FUEL DR.	7 POWER PLANT SUPPLIES LUBRICANTS DR.	7 POWER PLANT SUPPLIES DRILL FITTINGS DR.	7 POWER PLANT SUPPLIES SUNDRIES DR.	8 OFFICE EXPENSES DR.	9 ORE SORTING AND TRIMMING FLOOR LABOR DR.	9 ORE SORTING AND TRIMMING FLOOR SUPPLIES DR.	10 MINE EQUIPMENT LABOR DR.	10 MINE EQUIPMENT SUPPLIES DR.	11 MINE GENERAL LABOR DR.	11 MINE GENERAL SUPPLIES DR.	12 MINE MACHINERY MACHINERY DR.	12 MINE MACHINERY FREIGHT AND DUTY DR.	12 MINE MACHINERY INSTALLATION LABOR DR.	12 MINE MACHINERY INSTALLATION MATERIAL DR.	13 SURFACE IMPROVEMENTS LABOR DR.	13 SURFACE IMPROVEMENTS MATERIAL DR.	DISTRIBUTION CHARGED TO EXPLORATION	DISTRIBUTION CHARGED TO ORE PRODUCTION	DISTRIBUTION CARRIED AS ASSET	
									80 00											80	1
																					2
																					3
																					4
																					5
																					6
																		1 500			7
																		1 250			8
																		1 000			9
																		750			10
																					11
																					12
																					13
																					14
																					15

202

IO. GRAND JOURNAL, OR VOUCHER RECORD BOOK.

Upper half shows left-hand side, lower half right-hand side. Column headings and rulings only are indicated. The original is 18 inches high and each page is 22 inches wide.

the mine, and the credit column showing amounts debited other accounts for stores issued for use. No. 2 is left blank in the example for illustration of a provision for any unusual expenditure, such as may occur once now and again, of a nature not requiring the permanent setting apart of a column for that particular class of outlay. The Bank column (No. 3) has Dr. and Cr. subdivisions, but the former does not appear to be much used in this book. The latter contains a record of the amounts of all checks drawn on the bank in payment for labor, supplies, etc., such credits constituting compensating entries to those debiting the various accounts charged with these expenditures. If all transactions with the bank be passed through the cash journal this division might be headed "Accounts Payable." Columns No. 4 and 5, Exploration and Ore Production, respectively, are each subdivided into Labor and Supplies, and the latter further subdivided into Explosives. Illuminants, and Sundries. Ledger accounts are opened for all these sub-heads; for instance, the former has accounts as follows: Exploration, Labor; Exploration, Explosives; Exploration, Illuminants, and Exploration, Sundries, and the latter similar accounts under the general heading Ore Production, each, of course, having its distinguishing classification. These several accounts are debited every month with their total charges for that month, and, unlike the case of Power Plant and some other accounts, the totals of amounts so charged remain as ledger balances until the end of the year or other financial period. No. 6, General Expense; No. 8, Office Expenses; No. 10, Mine Equipment (a) Labor (b) Supplies; No. 11, Mine General (a) Labor (b) Supplies, are all first debited with their respective charges for the month; then entries are made in the ordinary journal crediting these accounts and debiting the respective Exploration and Ore Production accounts which have been opened under these headings in the ledger. The proportions charged to these latter accounts are governed by the number of "miner shifts" worked during the month at exploration and ore production, respectively. For example, if General Expense account (Division No. 6) has been debited with $500 this amount is dealt with at the end of the month by entry in the ordinary journal. Where say 50 miners have each been employed one shift on 30 days of a month a total of 1,500 miner shifts is obtained. Of these 900 have been on exploration work and 600 on ore production, which gives a proportion of 3/5 to the former and 2/5 to the latter, or $300 chargeable to General Expense, Exploration, and $200 to General Expense, Ore Production. The entry in the ordinary journal would therefore be as follows:

General Expense, Exploration.....	(Dr.)	$300.00	
General Expense, Ore Production.....	(Dr.)	$200.00	
To General Expense	(Cr.)		$500.00

General Expense account is thus closed for that month and the two accounts to which its debit balance has been transferred after subdivision remain open until the end of the financial period.

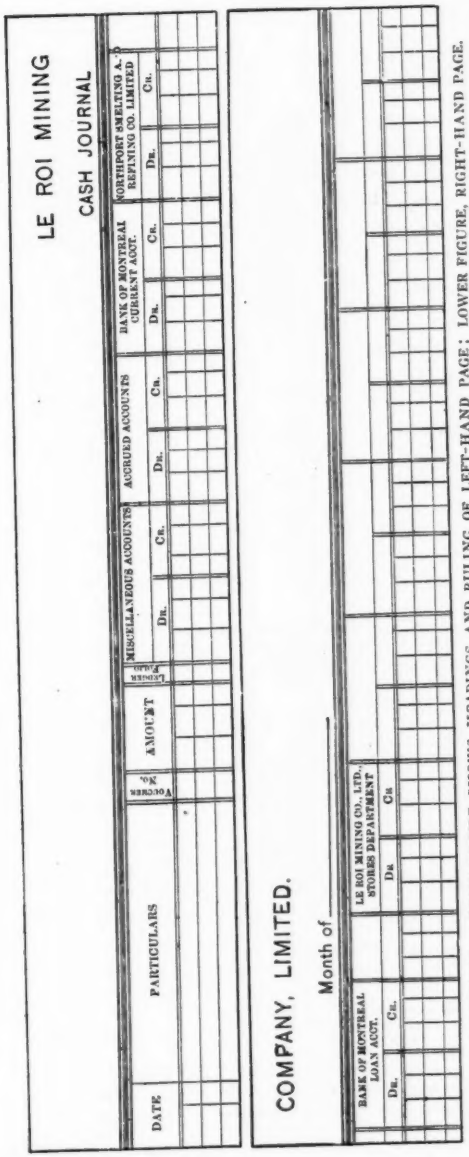
Power Plant accounts are disposed of similarly to General Expense, except that the number of "drill shifts," i. e., the total number of full shifts during which the machine drills in use have been worked during the month, rather than that of the miner shifts, determines the proportion of the distribution between the Exploration and Ore Production accounts. Power Plant, Labor, is sub-divided into Power Plant Exploration, Labor, and Power Plant Ore Production, Labor, whilst the four sub-divisions of Power Plant, Supplies—viz., Fuel, Lubricants, Drill Fittings, and Sundries—are similarly closed into Power Plant, Exploration, Supplies, and Power Plant, Ore Production, Supplies, these accounts also remaining open until the end of the financial period.

No. 9, Ore Sorting and Tramming to Railway (a) Labor (b) Supplies, are purely Ore Production accounts, the amounts debited to them being direct charges on account of Ore Production, and these remain open as well.

Mine Machinery, No. 12, is sub-divided into four accounts, which at the end of the year are all closed into Mine Machinery and Plant account.

Surface Improvements, No. 13, is divided into (a) Labor (b) Material, and these accounts are at the end of the financial period closed into Surface Improvements and Buildings account. They include all surface improvements of every description, such as buildings, ore bins, dump cribbings, gallows frames and other headworks, railway tracks for ore-shipping, water tanks, etc.

The unnumbered division "Distribution" contains three columns, to one or other of which all amounts appearing in the numbered columns are carried. The totals of Exploration and Ore Production columns of this division serve as a check on the Exploration and Ore Production charges for the month appearing in the other columns. The Asset column represents all amounts charged to accounts in divisions 12 and 13, together with sundry items of mine equipment supplies, such as ore cars, skips, machine drills, etc., which from their comparatively long working life are generally treated as assets whilst in working order.



12. CASH JOURNAL. UPPER FIGURE SHOWS HEADINGS AND RULING OF LEFT-HAND PAGE; LOWER FIGURE, RIGHT-HAND PAGE. THE ORIGINAL IS 18 INCHES HIGH AND ABOUT 40 INCHES WIDE.

The double-entry principle of the grand journal is illustrated by the specimen entries appearing in Example No. 10. That this is so is evident from the fact that the Bank of Montreal (Division 3) there shows creditor $4,580, whilst Exploration, Labor (Division 4) appears Dr. $4,500 and Mine Equipment, Supplies, (Division 10) is Dr. $80.—together $4,580, these constituting the double entry and agreeing with Total Transactions, $4,580 and also with the total of the columns of the division Distribution, viz., Exploration, $4,500 and Asset, $80.

The particular use of the book, stores journal, previously referred to as subsidiary to the grand journal, is to record all charges in and out for stores or supplies. It is sub-divided in part similarly to the

EXPLORATION

LABOR	TOTAL COST	COST PER CENT	CARRIED AS ASSET
Shafting			
Driving			
Raising			
Cross-cutting			
Station Cutting			
Winzing			
Timbering			
Totals			
SUPPLIES			
Explosives			
Illuminants			
Tools			
Timbers			
Lagging			
Timber Tools			
Lumber			
Totals			

STOPING

LABOR	TOTAL COST	COST PER TON
Breaking Ore		
Shovelling		
Timbering		
Timber Repairs		
Carmen		
Totals		
SUPPLIES		
Explosives		
Illuminants		
Tools		
Timbers		
Lagging		
Timber Tools		
Lumber		
Totals		

POWER PLANT

LABOR	TOTAL COST	COST PER TON	CH'GD TO EXPLOR.	CH'GD TO STOPING
Mechanics				
Comp. Engineers				
Hoist Engineers				
Electric Engineers				
Pump Men				
Firemen				
Repairmen				
Laborers				
Totals				
SUPPLIES				
Fuel				
Lubricants				
Drill Fittings				
Pipe Fittings				
Iron and Steel				
Electric Power				
Totals				

MINE GENERAL

LABOR	TOTAL COST	COST PER TON	CH'GD TO EXPLOR.	CH'GD TO STOPING
Foreman				
Blacksmiths				
Mechanics				
Powdermen				
Nippers				
Tenders				
Surveyors				
Laborers				
Totals				
SUPPLIES				
Iron and Steel				
Smith's Coal				
Illuminants				
Totals				

RESULTS OF OPERATING MINE

EXPLORATION

PLACE	FEET ADV'D	TOTAL NO. TONS ORE	NO. CARS WASTE
Ft. Level			
Ft. Level			
Totals			

STOPING

PLACE	SQ. FT. WALL EXP.	TONS PER SQ. FT.	NO. TONS ORE	NO. CARS WASTE
Ft. Level				
Ft. Level				
Totals				

EXTENT OF ORE SHOOTS OPENED AND ORE SHOOTS STOPED

Foot-wall Area of Ore Shoots Blocked Out by Exploration Work During Month	Sq. Ft.	To Date	Sq. Ft.
Foot-wall Area of Ore Shoots Stoped During Month Amounts to	Sq. Ft.	"	Sq. Ft.
Ore Extracted per Square Foot-wall Area During Month Amounts to	Tons	"	Ton

† Drifts are measured from centre of shaft. Raises from top of level below. Cross-cuts from side of drifts, and Stations from side of shaft.

Rossland, B. C., 190

II. MONTHLY SUMMARY OF DETAILS OF INFORMATION. LEFT-HAND SIDE.

The form is so large that it is necessarily somewhat condensed by leaving out blank and duplicate spaces—as in the spaces for the various levels, lower left corner. The other half is shown opposite.

ORE SORTING AND TRAMMING TO RAILWAY

LABOR	TOTAL COST			Cost per Ton Shipped		
Foreman						
Crushermen						
Ore Sorters						
Samplers						
Trammers to Waste Dump						
Ariel Tram Runners						
Mechanics						
Laborers						
Totals						
SUPPLIES						
Tools						
Oil						
Lumber and Nails						
Illuminants						
Carpenter Work						
Smith Work						
Totals						

MINE EQUIPMENT

LABOR	TOTAL COST			CHARGED TO EXPLOR.			CHARGED TO DEVELPT.			CARRIED AS ASSET		
Trackmen												
Pipemen												
Carpenters												
Machinists												
Blacksmiths												
Laborers												
Totals												
SUPPLIES												
Ore Cars												
Machine Drills												
Rails												
Columns												
Stoping Bars												
Lumber												
Pipe												
Pipe Fittings												
Electric Wires												

ORE RECORD

Crude Ore Hoisted	Tons
First Class Ore Delivered to Smelter	Tons
Second Class Ore Delivered to Smelter	Tons
Waste Delivered to Dump	Tons
Cost per Ton First Class Ore Delivered on Railroad Cars	
Cost per Ton Including all Mine Expenditure	

CARRIED AS ASSET

MINE MACHINERY LABOR	APPENDIX A					
Installing						
MINE MACHINERY SUPPLIES						
Installing						
SURFACE IMPROVEMENTS LABOR	APPENDIX B					
Installing						
SURFACE IMPROVEMENTS SUPPLIES						
Installing						
MINE EQUIPMENT						
Carried as Asset						
Charged to Exploration						
EXPLORATION						
POWER PLANT						
MINE GENERAL						
GENERAL EXPENSE	APPENDIX C					
SUPPLIES ON HAND						
Totals						

RECAPITULATION

OPERATING EXPENSES						
STOPING						
Labor						
Supplies						
POWER PLANT						
Labor						
Supplies						
MINE GENERAL						
Labor						
Supplies						
ORE SORTING & TRAMMING TO RY.						
Labor						
Supplies						
MINE EQUIPMENT						
Labor						
Supplies						
GENERAL EXPENSE	APPENDIX D					
Manager's Office						
Mines Office						
Assay Office						
Contingencies						
Charities						
Totals						
EXPENDITURES CARRIED AS ASSET						
Mine Machinery						
Ore Sorting Machinery						
Surface Improvements						
Mine Equipment						
Exploration						
Power Plant						
Mine General						
General Expense						
Supplies on Hand						
GRAND TOTAL ALL EXPENDITURES						

General Manager

II. MONTHLY SUMMARY OF DETAILS OF INFORMATION. RIGHT-HAND SIDE.

As in the case of the other half, shown on the facing page, the form is slightly condensed as well as reduced in size. The entire original form is 21 inches wide and 18 inches high.

grand journal, omitting all columns for record of labor charges. Its first debit column starts with the amount or cost value of all supplies on hand at the beginning of the month, and to this are added all purchases during the month. Its credit column contains all credits to Stores General for stores issued during the month, the distribution of these amounts appearing on a voucher, particulars of which are entered in the grand journal, through which they are debited to their various supply and material accounts. The excess of the total of the first debit column of the stores journal over that of the credit column represents the value of the stores on hand at the end of the month, and this amount is carried forward as the first debit in the new month.

The grand journal footings of divisions 1 to 13, both inclusive, are posted monthly to the ledger. At the end of the financial period all ledger Exploration accounts are closed into Mine Exploration and Development account, and all Ore Production accounts into Profit and Loss, or are otherwise dealt with as the management shall direct.

The sheet exhibiting details of mining operations, Example No. 11, gives a monthly summary of all information, relative to expenditures for labor and supplies during the period under review, obtainable from the grand journal and other sources; also costs per foot of development and per ton of ore produced. In connection with Exploration (or Development), it shows the number of feet of advance made during the month in each part of the mine in which men have been employed, and the total footage to date accomplished in each working, together with tonnage of ore and waste, respectively, taken from each working during the month. In connection with Ore Production or Stoping it furnishes information relative to the tonnage of ore and waste handled, tonnage of ore per square foot stoped, tonnage delivered to smelter, and costs per ton. It also shows what proportion of expenditure is being carried as an asset, giving, where necessary, particulars in appendices, and states separately the expenditures charged to capital and labor, respectively. Further, it gives extent of ore shoots opened up and those stoped, and altogether supplies to the head office, under the signature of the manager, much information in compact form and clearly stated.

Whilst it is scarcely expected that the foregoing descriptive matter, together with the accompanying examples of book rulings and headings and of forms in use, will enable a novice to carry out a similar system without more particular instruction, it is hoped that to those familiar with account keeping it will be sufficiently clear to enable them to grasp its principles and appreciate its merits.

TELEGRAPH ENGINEERING IN MORO LAND.

By a Member of the Corps.

The writer of this article is serving with the signal corps of the American forces in Mindanao, but prefers that his name should not appear.—THE EDITOR.

THERE is a class of men in the army of whom one seldom hears much, but who are of essential value to any undertaking of the Government in a new land. I refer to the members of the signal corps. It may be interesting to note some of the characteristics of the life of the signal-corps man in Moro land. In the first place, he is selected from among the recruits offering themselves at the enlisting stations in America, or from among the organized troops in the islands. The inducements for young men to enlist in the army as telegraphers are not so very great, yet the first-class sergeants of the corps receive practically almost as much pay as second lieutenants of the line, when rations, clothing, etc., are taken into consideration. It is by no means uncommon now-a-days for the privates of the corps to work their way up and eventually secure commissions. Still, the advantages and privileges do not tempt the bright young men of the telegraph fraternity to the extent desired by the officers, with the result that in most stations men are detailed from the troops to assist. In the Moro campaign of 1902 it was necessary to secure a number of experienced men from the companies to aid the corps. In an army one can find all sorts of men, and in every regiment there are always two or three men who were formerly telegraph operators, machinists, engineers, teachers, lawyers, and the like, representing all trades and professions. The material available for the signal corps therefore is good. Often the man transfers from the organization to which he belongs to the corps.

In the field it was our practice to throw up a fly, canvas, or sometimes only a shelter-half, and under this place the instrument and get

to work sending and delivering messages with the wire on the ground. If possible, gangs of natives were secured and light poles put up to string the wires. If permanency of the camp were assured,

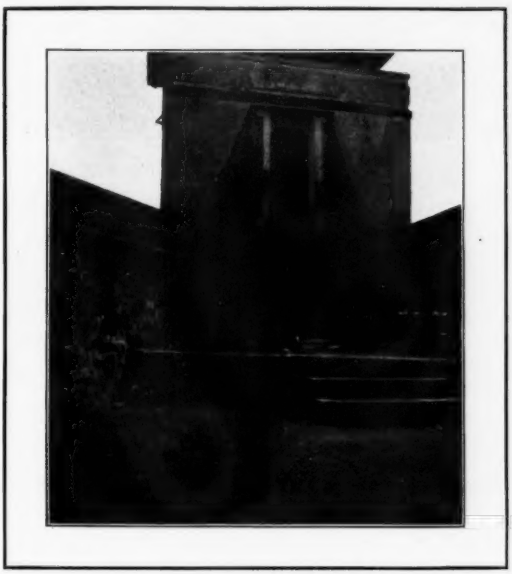
THE EXTERIOR OF TOWER TELEGRAPH OFFICE IN AN OLD FORT.

TELEGRAPH OFFICE IN AN OLD SPANISH FORT.

then the corps would undertake to establish a good line on cocoanut or other strong poles. But in garrison, one has only to look for a

cosy nook in one of the Spanish forts and here he finds not only excellent quarters for office work but a good place to sleep in.

The Spanish took every precaution to protect their telegraph and signal towers, and usually employed one of the corner or end towers of the fort for the purpose. There is no possible means for entering at the front or sides, because it is all solid masonry. The rear door is about twenty-five feet above the ground and is reached by steps. These steps can be hauled up for protection. There are several port



THE GUARDED ENTRANCE.

holes in the tower, and as the signal men are properly armed, a good resistance could be made in the event of a Moro attack.

The signal corps could hardly get along without native helpers to do the heavy laboring and line work in Moro land. The Moros do not take to work, and the signal sergeant or corporal has to use considerable tact to hold his gang together for purposes of working. The natives have many *festa* days, and the first thing you know all hands lay off a day and you may threaten and coax and they will not return to work. I have had operations stop on a raft in the middle of a stream, because these fellows quit work for some pretense. If a child is slightly ill at home, if the wife scratches her finger, if the man him-

FIELD MESS TENT AND LAUNDRY.

self is very slightly indisposed, or any little thing occurs to disturb the harmony of the usual run of things, the lazy Moro finds in it ample excuse not to work that day. While they do work, these agile natives are handy. They can go up a pole without spikes very quickly, and if you stand under and make them do so, they will connect up the wire well. They will put on an insulator correctly, if you watch them. But you must watch them very closely, otherwise they will be very slipshod and the work will fall to pieces quickly.

Signal corps men in the States and in settled sections of the islands are not as a rule mounted. But here in the land of the Moros, where there is occasional activity, no one cares very much if you own and ride a horse. I purchased a native pony for $12 gold. I got a saddler of one of the cavalry troops to make a bridle for $2, the quartermaster let

SUPPLIES GOING TO THE FRONT. THE HOUSES ON THE LEFT ARE THE SHACKS OF NATIVE HELPERS.

me have a condemned saddle, and I am fitted out in good form and can use the tough little beast to go anywhere. I let him run with the other horses and he fares well. Some of the corps are temporarily mounted on American horses.

I have letters at hand from friends in the fraternity at home inquiring about our method of living. We usually club together and hire a

A FIELD REPAIR SHOP.

native or a Chinese cook, and with the ration which is issued us, consisting of coffee, pepper, salt, vinegar, flour or bread, some canned meats, tomatoes, pickles, etc., we can get up a good mess, especially as we have access to the sales commissary where it is possible to buy the best kinds of canned fruits and the like. It costs us about 28 cents per day each for the mess. This covers cigars, etc., and the expense of entertaining members of the corps passing through. We do not have to wash our clothes, as a friend asks; the laundry is done by one of the troop soldiers detailed for the purpose, who charges us one dollar per month, and in turn uses the money to pay native washermen, and buy starch, blueing, soap, etc. He makes a slight profit on the enterprise.

Probably the signal men are bothered more in this new Moro land about supplies and means of making repairs than any of the men in the older sections or more settled posts. Down here in far southern Zamboango, Malabang, Cottobatto, and Parang, we are quite away from the other places. Often as much time expires in getting mail and supplies for the signal corps from Manila to us here, as from San Francisco to Manila. The result is that considerable ingenuity is re-

WHERE SOME BRAVE MEN LIE.

quired on the part of the men who possess a mechanical turn. Nearly all have been trained in mechanics and understand metals and mechanisms, and in the event of some part breaking or wearing, are usually able to replace the part with one shaped by hand or repaired with patching. Usually a tent is put up and a rough bench installed, and here the tools and fittings of the corps are placed in readiness.

The signal men have three or four classes of enemies of the wires to deal with. First there are the ladrone Moros, who chop out sections of the line for the sake of the wire for mechanical use on their farms. Then there are the foes who cut down poles and fell trees across the wires and the like to cut off communication and you have to travel out in the rains or the night with a small guard and half a dozen linemen to repair the break. Then the white ants are a bother, for they eat the woodwork of the poles in places in a few months and the pole topples over. Then there are the gales that sweep débris on the wires and stop operations. Earthquakes have occurred twice in the past year with such violence that the wires have been wrecked along mountain sides by landslides. It is hard work for the non-commissioned officers and the privates of the corps, as well as for the commissioned officers; but all work well together and with a will that is astonishing. The result is that communication is maintained between all these posts in the southern portion of Mindanao, about the seat of the recent Moro troubles of Lake Lanoa.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

By Robert Buchanan.

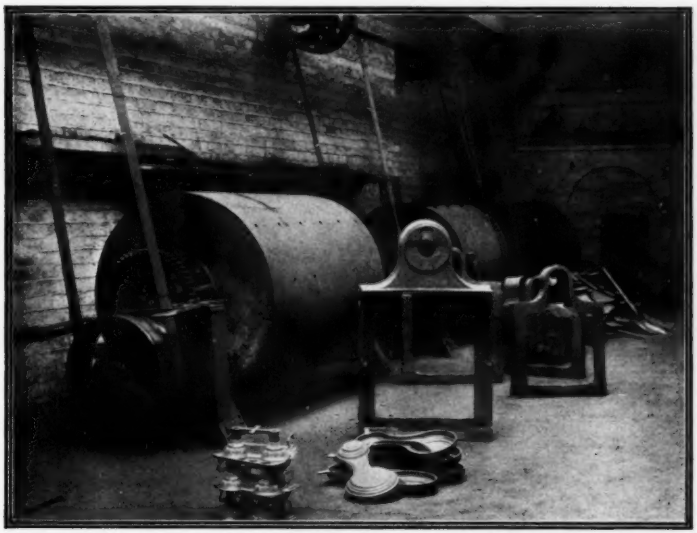
VI.—THE DRESSING OF CASTINGS.

Mr. Buchanan's first article appeared in our issue for December, and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor; his third, moulding by hand and machine. The fourth paper took up the specification and purchase of supplies, and the fifth dealt with the management of the cupola. The concluding article, which will appear next month, will review the "Qualities and Training of the Foundry Manager."—THE EDITORS.

IN fettling or dressing castings the tumbling barrel, or "rattler" as it is sometimes called, has an important part to play. Whether it be octagonal or round in cross section is much a matter of indifference, though the octagonal barrel may in some degree tend to increase the movement of the castings during the process of tumbling. Octagonal barrels are usually made of cast iron. The circular or cylindrical barrel is almost always of wrought iron or steel plates. As almost everyone is aware, the castings as they come from the foundry are put into these barrels, and for a number of hours more or less are tumbled or "rattled" together, with some material which is put into the barrels along with the castings, so as to increase the action on the surface of the castings. It is not uncommon for barrels made of wrought iron or steel plates to have the heads of the rivets protruding inside the barrel, with the result that the castings soon wear them away sufficiently to allow the remaining parts of the rivet heads to be drawn through the plates, and so the barrel readily comes to pieces. All rivets or bolt heads should be flush with the inside of the plate, and if that is not possible owing to the thinness of the plate, then such projecting heads ought to be covered by means of a casting which is itself held in place by bolts which are flush. Shafts ought not to pass through the length of the barrel from end to end, as they hinder in a very considerable degree the filling and emptying of the barrels. As everyone is aware considerable dust is formed during the course of tumbling. To have the quickest and best results, this dust must find its way out of the barrel. If the barrel be so tight as to retain the dust, the latter acts as a kind

of lubricant between one casting and another, retards the smoothing effect of the tumbling, and renders necessary considerable brushing of the castings to make them presentable when got out of the barrel. In many cases the dust is withdrawn through a hollow shaft on one end of the barrel, the exhaustion being accomplished by means of a suitable fan. This leaves the castings in the best condition for smoothing one another. In Europe such a system of exhausting the dust is not at all common, and so the building in which the barrels are situated is probably the most unhealthy part of the foundry. It is hardly too much to say that tumbling barrels not fitted with a system of exhaust ought to be forbidden by law.

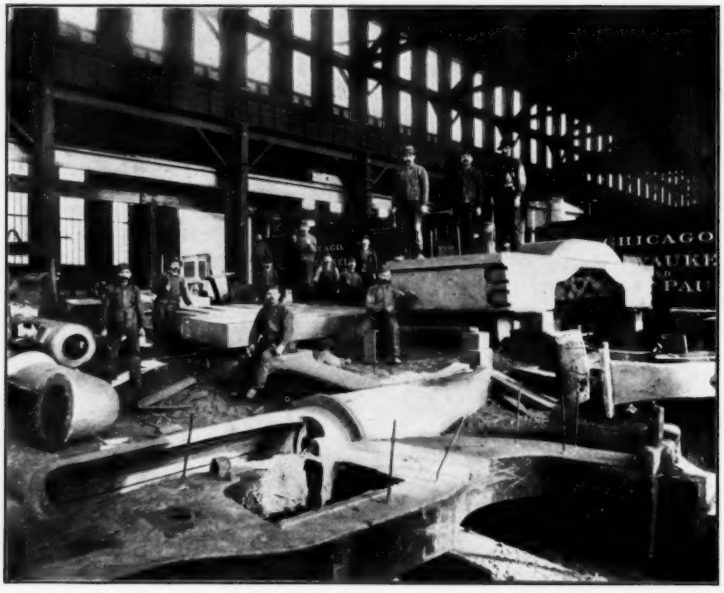
As regards the size and class of castings which may be tumbled, this is largely a matter for judgment by the foundrymen. On the one hand, castings may be slender and fragile, or have delicate figuring on the surface which will be blunted and defaced by the tumbling, or, on the other hand, castings may be so large that the tumbling either breaks them or they break other castings which may be along with them. Castings as nearly alike as possible in size and character should be put into each barrel. The size of casting which may be profitably tumbled is limited only by the size of the barrels and facilities for handling the castings. Foundries mostly use one of three things as the material to be charged into the barrels, along with the castings. These are stars of chilled cast iron, "gits" off the castings themselves, or slag from the cupola. Of these, the gits are probably the best to use; being constantly produced, they may be renewed as often as necessary, and the tumbling cleans them from adhering sand, making them in still better condition for melting in the cupola. The stars are excellent for tumbling purposes, but cost money to produce. Slag from the cupola is often used, costing nothing but the labour of bringing it to the barrels; but it has the great disadvantage of causing excessive quantities of dust. It has an advantage over the stars or the gits inasmuch as it does not so readily find out the "kishy" or spongy parts of the castings. If using stars or gits greater attention has to be devoted to the gating of the castings, so that they may be clean and sound, if the discovery of more than a moderate percentage of waster castings by means of the tumbling is to be avoided. The number of castings broken in the course of tumbling gives an excellent indication of whether the mixing of iron at the cupola is right or no. A large breakage of castings may be laid to the account of bad mixing or bad melting, or both, rather than to back packing of castings in the barrels.



CORNER IN THE TUMBLING-BARREL ROOM OF THE SOHO FOUNDRY, BIRMINGHAM, ENGLAND.

The nearest barrel is 4 feet in diameter; in it are tumbled castings each weighing 250 pounds. Each casting is subjected to a series of more than 5,000 shocks. Breakages are practically unknown.

In 1896 A. E. Outerbridge brought to the notice of foundrymen the results of a series of observations regarding the effect tumbling has upon castings. These observations were amply confirmed by a committee of the Franklin Institute. It is hardly too much to say that within the last ten years, no matter of greater importance has been submitted to the notice of makers and users of castings. Every foundryman is aware that castings in the course of cooling are subject to various strains, strains which sometimes result in fracture. Outerbridge has shown that such strains exist in every casting, no matter how simple the form. Even test bars subjected to tumbling gave results 10 to 15 per cent. higher than those not so treated. In the experiments by the committee of the Franklin Institute some of the tumbled bars were increased in strength by 35 to 40 per cent. The idea is that the strains due to cooling are dissipated or distributed by the repeated knocks and shocks encountered in the course of tumbling, and that such dissipation takes place exactly in the same degree as the shocks are in number and force. Such an effect is, however, modified in some degree by the quality of the iron itself, as



DEPARTMENT FOR CLEANING HEAVY CASTINGS, ALLIS-CHALMERS SOUTH FOUNDRY.

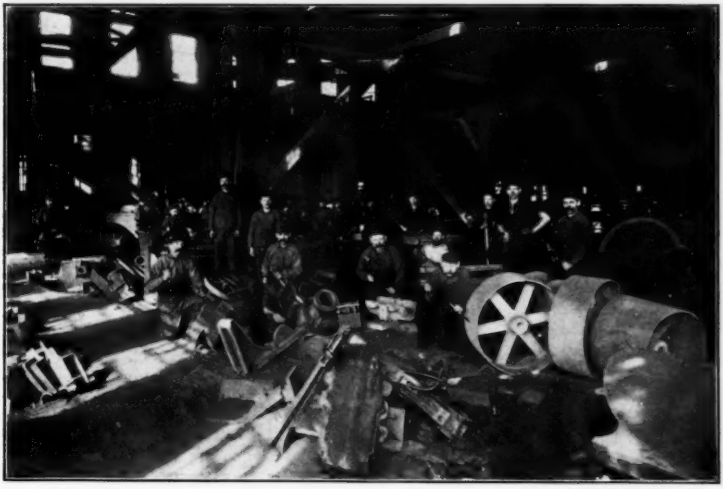
regards hardness and softness. Hard or strong irons exhibit the highest results, soft irons the lowest. This is what one might expect, as hard irons are subject to greater cooling strains. The effect of tumbling is thus in some degree similar to that obtained by annealing, but in the latter case certain changes of chemical composition (and particularly of the carbon) take place, which do not obtain when tumbling is resorted to. Outerbridge also discovered that castings which would break if subjected to blows of a certain force at the beginning would withstand these successfully if applied after being led up to with a series of blows gradually increasing in force. He contends that the dissipation of the cooling strains by a series of shocks such as tumbling gives is due to the vibration of the molecules allowing or aiding them to take up a new relationship to one another.

Professor Ledebur thinks that the change which results in making tumbled castings stronger is due to the shock acting upon the skin of the casting which has got into tension during the process of cooling. That a certain stretching of the skin of the casting, due to impact takes place during tumbling, is very possible. It is probable, however, that this is a subsidiary cause; that the rearrangement of the molecules

is the primary cause is more probable still. Whether the strengthening of castings by tumbling be due to the stretching of the skin as suggested by Professor Ledebur, or to the rearrangement of the molecules as maintained by Outerbridge, it is scarcely possible to exaggerate the immense importance to foundrymen of the fact itself.

As castings may fracture at the beginning of barreling from shock which they otherwise would have withstood successfully later, it is a simple deduction that the castings should have small shock and movement to begin with. How is that to be accomplished? Barrels should have two speeds, a fast and a slow. Start with the fast and finish with the slow speed. The shock is greater with a slow speed, as the castings have time to fall through a greater distance.

The use of the sand blast with a view to improving the appearance of the castings by making them smoother has been doubtfully successful. Sand blast may be useful in getting the scale off steel castings, which have been subjected to annealing in an oxidising



"SCRATCH ROOM" AT SOUTH FOUNDRY OF THE ALLIS-CHALMERS COMPANY.

atmosphere, but steel castings do not usually occupy the position of being exemplars of what the skin of a casting ought to be. The sand blast may clear the surface of iron castings of carbon and siliceous matter with a view to substituting on such surface some other metal or material, but it will not smooth the surface of rough castings. The stream of sand projected against the casting bites into the surface

at the same rate all over such surface, and as the body of the casting is worn away at the same rate as the projecting roughness the result is unsatisfactory. Sand blasting may actually make rougher a casting which was previously smooth. Thus it is my experience that unless for special and specific purposes, sand blasting is of little use to the ordinary iron founder.

SAND-BLAST MAN READY TO PUT THE BLAST ON, SCHENECTADY SHOPS OF THE GENERAL ELECTRIC COMPANY.

Castings to be used for engineering purposes, and upon which much machining has to be done, are often dipped into dilute acids so that the silicates formed on the surface of the castings may be dissolved, and so less readily blunt the tools with which the machining is done. The dilute acid also dissolves the combined carbon on the surface of the casting. It does not dissolve the graphitic carbon. Sulphuric acid and hydrofluoric acid are used, the former being most in use, but it has considerable effect upon the iron itself. Hydrofluoric acid attacks the silicates and has less effect upon the iron itself, but is more expensive than the other. When using sulphuric acid the dilute acid is contained in a wood trough with lead lining. The castings are packed into a wood box, with perforated bottom, the straps holding the box in shape and by which it is suspended being of copper

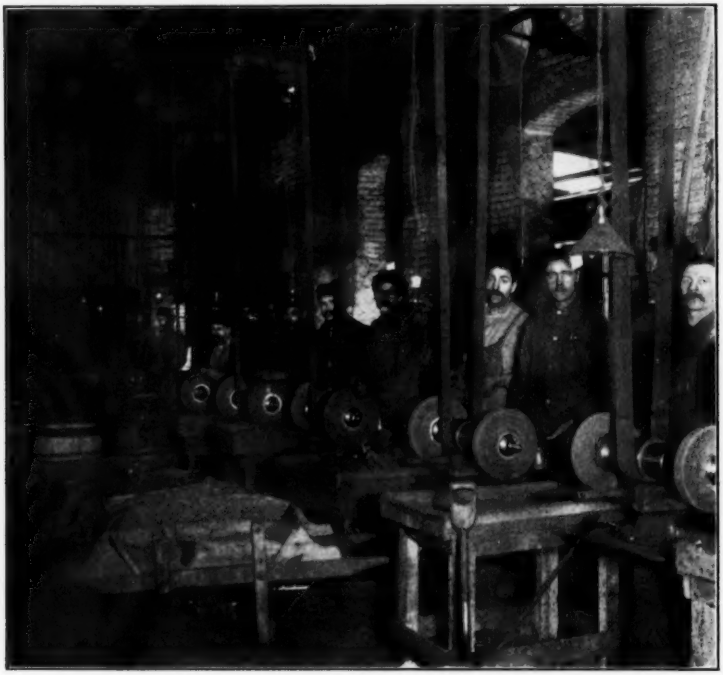
fastened with copper rivets. The box containing the castings is lowered into the dilute acid, when vigorous boiling takes place if sand has been left in the core holes. After an immersion of about twenty minutes the box containing the castings is hoisted up, allowed to drain back into the trough containing the acid, and is thereafter swung aside and drenched with plenty of clean water. Such a course of treatment, however, is advisable only where machining has to be done. It is detrimental to castings which have to be sold largely by their appearance, as the acid sets up a vigorous oxidation or rusting, which detracts very much from the appearance of the castings.

CLEANING CASTINGS WITH ELECTRIC-DRIVEN EMERY GRINDER IN THE BROWN & SHARPE SHOPS.

The grinder is driven through flexible shaft; Stow Manufacturing Co., Binghamton.

When fettling or dressing castings abrasive wheels play an important part. These consisted, until recent years, of emery or corundum or mixtures of these. Within the past few years to these has been added a formidable rival in carborundum. Emery and corundum are natural products; carborundum is a manufactured article, produced by means of the electric furnace, being manufactured by the Carborundum Co., of Niagara Falls, N. Y. Emery has less abrasive

or grinding power than corundum, and corundum less than carborundum. As corundum has greater cutting powers than emery it was selected for a comparative test with carborundum, the latter costing 12 shillings more than a corundum wheel of similar size. On two grinding machines of similar size and speed driven from the same shaft there was put on one a corundum wheel 20 inches diameter by 2 inches thick, and on the other machine, a carborundum wheel of similar size. The wheels were run at a speed of 950 revolutions per minute. One man worked day about on each wheel, fettling exactly the same class of castings. The corundum wheel lost 4½ inches of

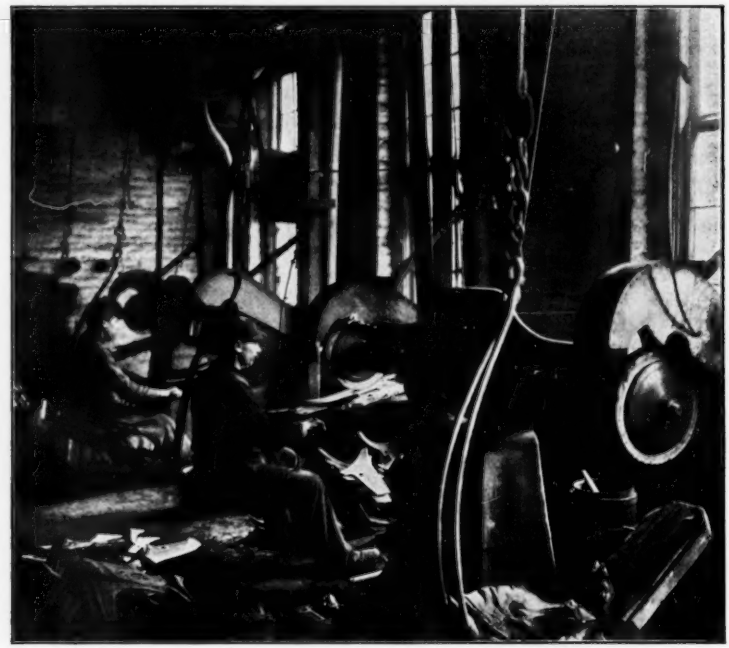


CARBORUNDUM WHEELS IN GRINDING ROOM OF THE WHITINSVILLE MACHINE WORKS, CAST-IRON DEPARTMENT.

diameter in 27½ working days, and fettled 46 tons of castings in that time. It was then taken off and a wheel made of a mixture of corundum and emery was put on in its place and worked for alternate days, as before stated. This wheel lost 3½ inches of diameter in 11 working days having fettled 19 tons of castings. The corundum and

CLEANING CASTINGS WITH ABRASIVE WHEEL DRIVEN BY STOW FLEXIBLE SHAFTING.
Stow Flexible Shaft Co., Philadelphia.

emery wheel was a faster worker than the wheel made of corundum only, but as will be seen wore away very much faster. To come now to the carborundum wheel, which was a faster worker than either. At the end of 157 working days it had lost 3½ inches in diameter and 14 pounds in weight. During that time it fettled 259 tons of castings. That is a wonderful record. Carborundum wheels do not glaze, and keep a cutting surface from first to last.



CARBORUNDUM WHEELS AT WORK ON CHILLED IRON PLOUGH POINTS.
Syracuse Chilled Plough Company.

Pneumatic chipping tools have obtained considerable attention in recent years. That they are suited for chipping heavy castings made in dry sand or loam there is no doubt, but they are not so successful on all classes of work. They are not suited for chipping light "fins" or "flash" as the tool readily jumps unless there is a good resistance in front. The adoption of the pneumatic chipper is often difficult owing to the foundry yard where large castings are fettled or dressed being in many cases at a distance from the available power. When this difficulty is overcome by the conveyance of compressed air to the tool they may be profitably used for heavy chipping. In calculating the advantages obtained from the use of these tools it is well, however, to remember that the power necessary to actuate these tools is rather considerable. Each of them absorbs from 1½ to 2 horse power.

Files.—When a foundry is in close business relations with the branch of engineering where the castings are fitted up, a profitable arrangement for both may be made by which the foundry dressers

use up the files first used by the engineers, or machinists, as they are called in America. When engineers are on day work they may not be so particular about using a half-worn file, but piece workers demand newly cut files and plenty of them. It pays to give them these, especially if another class of workers, such as dressers, can utilise the files, which for their purpose are as good as new ones. In one works the adoption of this system resulted in a saving of nearly £100 per annum in files for dressers' use. To carry out this arrangement successfully there must be some common sense used. The engineers are not to have such difficulty in getting files exchanged that to prove they are past work they previously give them a few rubs on the hardened jaws of a vise. Neither should they be forced to work them until the files are so smooth that no man, be he engineer or dresser, can profitably work them, for this makes the transfer from engineer to dresser merely an added waste of time. Let the engineer leave the files with some work still in them; the dressers will soon make them smooth enough.

Inspection of Castings.—Where moulders are paid by piece work, the inspection of castings becomes an important matter and the results are often such as do not tend to make the inspector a popular personage. Popularity with the men could readily be obtained, but the inspector would probably get into trouble elsewhere. Where the standard of quality of castings is high, differences of opinion as to whether castings should or should not be rejected more readily arise, and it is well that the manager, or superintendent of the foundry, should consider himself as a "Court of Appeal" should sharply marked differences of opinion prevail. The knowledge that the manager or superintendent of the foundry not only permits but invites such appeals to him tends to prevent these differences taking an acute form, and at the same time provides against bias being unjustly exercised for or against any man. The bribing of inspectors so that they shall pass doubtful work is not unknown, but when the manager takes a close interest in the inspection and rejection of castings the giving or taking of bribes becomes a very dangerous course to pursue. The foundry manager ought to visit the scrap heap to view the waster castings every day, and early in the day. It is the waster castings that need looking after; the good castings look after themselves.

When waster castings are produced, say by faulty cores or dull iron, either of which may not be due to the moulder, it is sometimes a cause of trouble when the moulder is made to stand the loss of the castings. This may occasionally be a hardship, but the general good

demands its enforcement. No management worthy of the name will ask the moulders to use bad cores, or cast with unsuitable metal; neither should it allow the moulder to cause losses by using materials which he knows will result in waster castings. When the moulder is aware that he takes all the risks in using doubtful materials, he takes good care that so far as he knows no such risk shall arise, and thus the policy mentioned tends to economical production.

It is advisable to cause each moulder to mark his castings in such a way as to enable their identification, either when immediately produced or afterwards when they are being worked up into finished goods. This may be done either by means of numbers or initials, the latter being the better plan unless the number of hands employed is exceedingly large. The knowledge that at all stages of its progress and at all times a casting may be traced to its producer, causes an amount of care and attention to be devoted to the castings which is obtainable in scarcely any other way. Whether castings be produced on day's wages or on piece-work rates, it is advisable to note daily the number and weight of castings produced by each individual. Neither system of work can produce satisfactory results unless this be done. The idea that his work will slip through unnoticed amidst that of many others is demoralising to any worker, whatever position he occupies. Without individual responsibility results are bound to be unsatisfactory. This system of checking individual output not only has the effect of checking waste of time and bad work, but is also a measure of the value of the better workman. Where piece-work rates are paid when extra work is to be done, involving payments beyond those fixed for the job, a book in which these extra payments are entered should be used, and from this book such extra payments are extracted for invoicing purposes. The use of the "Time allowance" book makes such payments regular in amount, forms a constant record of why and to whom such payments are made, and thus tends to prevent fraud or favouritism between foreman and men.

COST REDUCTION BY THE USE OF THE PREMIUM PLAN.

By C. A. Colwell.

Mr. Colwell's article is a straightforward story of five months' practical, personal experience introducing the premium plan into a large shop. The reductions of time are surprising, and are given in specific detail for standard pieces and operations. The definiteness of the paper makes it especially valuable, and the side lights on successful methods of dealing with men of various temperaments and capacities and of stimulating production throughout the works are very interesting.—THE EDITORS.

THE following article gives a brief record of the results of five months' work in putting the premium system on a firm footing in a works employing about six hundred men in machine, boiler, smith, and erecting shops. The machines are not of the latest pattern; the castings are not of as even a grade as could be desired for a perfect scheme of timing, and worst of all are the "rush express" orders, which must be gotten out; in most cases a man finishes his cut on the piece in his machine and puts in the "rush express." He puts in his best efforts to get rid of it and yet make a job that will pass inspection, so as to get back at his premium work. So much for the material I had to start with. The records will show the immense advantage which the premium system, when properly handled, can secure to both employer and employee.

The time keepers in the departments were young fellows who received 15 to 17½ cents per hour, and their sole duty was to keep accurate time on the work—one in the smith shop, one in the boiler shop, one on the erecting floor. The machines were under my direct supervision. When the times had been gathered and tabulated, the boiler and smith shop were each left under the care of one man; the smith shop has fourteen fires and three steam hammers to be cared for; the boiler shop has three radial drills, one countersunk drill, and four air riveters.

In boiler and smith shops the time was set by the job, except the drilling, which was by the piece; ordinary methods of figuring could hardly be used in these departments, because of the awkward shapes of the pieces.

Now that the limits have been set in nearly all departments, the boiler and smith shops are kept by one man, the erecting and engines

and machines by another, and the drills are under a foreman who keeps the time and work to be given for all the drills. The output on the drills has been tripled, and now instead of having huge piles of work accumulated all around the drills, it is a hustle to get work for them, simply because each man is alive to the possibilities of each piece of work, and thinks if he does not make two hours for himself,

Machine No. 66 Operator M Dinklemann Date 10/24

			TIME	PREMIUM
6-6 45	Sheaves 4745 A	(1)	3/4	1/4
6 45 10 45	" 17361 3	(3)	4	1 1/2
10 45 1 45	Hand wheels	(6)	3	1
1 45-3	Bearings (solid) 9019	(3)	1 1/4	
3-6 30	" " 12887A	(3)	3 1/2	

Machine No. 66 Operator O Dinklemann Date 10/30

			TIME	PREMIUM
6-6 30	pipe flanges face .5		1/3	
6 30 11 30	" " thread 45	(5)	5	3
11 30 4	" " "	(2) 14	4	1
	" " "	(2 1/2) 9		
	" " "	(1 1/2) 6		
4-6 30	Sheaves 5455113		2 1/2	

SAMPLE BLANKS AND ENTRIES OF TIME RECORDS.

which also means two hours for the company, he is doing a poor day's work. Some times and pieces will be given later.

There were already in use some blanks on which time was kept; for each machine and each piece of work, some times had been secured and were used as a working basis. From the daily time slips, at the end of each month, were gathered the times—both individual and combined—on the various pieces machined and entered on the piece slips. Records were obtained also from the machine book; it was kept

in the same way as the piece slips, with the exception that it was for the machine on which the piece was done, so there were three records—the daily time slips, the piece slips for office use, and the machine book for machine-shop and premium-clerk's use. Where a piece had been timed it was entered in the machine book under the name of the machine on which the work had been done.

The worst difficulty in getting the men to accept the premium system was the fear that if they did go at it in the proper spirit and work the machine to its limit and burn tools occasionally, their limits would be cut, their wages cut, and finally their space become of more value to the company than their services. Indeed, when such results have been obtained as are hereinafter shown, it is but natural for the company to feel that it had been systematically swindled and to seek redress by a cut; yet this is one of the worst possible things any company can do, as the men will pass it very quickly from shop to shop; it is this very cutting by employers which has caused the premium system, piece work, and other bonus plans, to be discouraged by labor unions and all fair-minded workmen.

A trouble which was met as soon as the premium time had begun to get a foothold, was that the day men and night men each complained about the condition in which the other shift left the tools; that was easily settled by a duplicate set of tools for each man and a cupboard to keep his own tools in. The next difficulty was over pieces which took fifteen, twenty, or thirty hours, to complete. If there were several of the same kind, each man had his own piece and worked on it till quitting, and the man on next turn took it out and put his piece in. The pieces were small, that is to say, 6 by 6, 7 by 7, 8 by 8, or 9 by 9 cast-steel crank shafts. But in case the piece could not be removed readily from the machine, the time of working the piece was divided up between the various operations. Taking, for example, the 7 by 7 crank; if only one was to be done, by night and day man, it was divided up in the following way:

Roughing ends to $^1/_{32}$ and fitting collars, six hours; roughing and finishing pins and eccentrics, thirteen hours; finishing ends, seven hours. The old time on a 7 by 7 crank was forty hours; the time above—twenty-six hours—is what was set; the work is now being done in twenty, so the operator makes for himself from 2½ to 3½ hours every two days, depending on the quality of steel in the casting.

If the piece in the machine at quitting time is nearly finished, I allow the man the proportion of time he has worked on it irrespective of what the man on next shift does; that is, if the piece is three-fourths

or more finished, sometimes for a steady workman, one half is allowed. I find that the night shift never does as well as the day shift. For some reason they do not run at as high a speed or take as heavy a cut; it is just the same if a day man, who has made premium, goes on nights; he seldom gets any premium.

On two 42-inch lathes of the same make, there are two men of different nationalities, strong union men; they would not take premium, and how to get them at it was a puzzle. Seeing them quarreling one day, I used it as a basis and cautiously egged them on, telling one that the other said he could do a certain piece of work in three hours. "Well," he remarked, "if he does it in three, I will do it in two and one-half." Not long afterwards, I had a chance to let them go it.

It was a drum with a friction housing; it had to be bored from 4 inches to 5 inches and rims turned for the housings; the piece had been taking five to five and one-half and sometimes six hours. Setting the limit at five and one-fourth, I let one fellow have them all. This did not just please the other man, as he was not making anything on it. One day, when a number were to be done, I let number one get started and then let number two have one. He said something about "number one being slow and not knowing what a lathe was;" at any rate, he started after number one and each did as he said—three, and two and one-half hours on the work. Now it is war to the knife on both machines, and the way work comes from those two lathes is a joy to the machine foreman and superintendent; and what is more, the fit and workmanship are perfect.

One piece number one does that has never been equalled is a cast-iron nut to bore and thread. It is cored to 2¾ inches and has to be bored and threaded for a 3⅞ screw, square thread, two threads to the inch. The bore is 12 inches long; it is a piece of work that is awkward to set up and get true. The time formerly taken to do it was from two and one-half to four hours; the limit was set at two and one-half. This man does nine and one-half in ten hours.*

Other classes of work on these two machines are crank discs for engines from 10 by 14 to 16 by 19, spiders and gear rims, drums and housings, and large shaftings. Some of the times made on the above are as follows: The crank discs have to be faced off on the rims, filleted on one side, shaft hole bored 3⅞ hub, faced, and filleted. The time set was one and three-quarter hours. When the man has six

* Since this was written, he has increased his output to ten and one-half in ten hours.

or seven, he does them in the average time of one hour. They used to take two hours. When one operator has several pieces, the total time from start to finish is taken and he is given premium on that time, unless there are unavoidable delays, such as waiting for crane, broken belt, or wait for special tools. These are not charged against the men.

A drum of which both ends must be turned to fit housings used to take five and six hours; the limit, five and one-half hours, produced three and sometimes four a day.

Spiders which have the ends of the arms turned to fit gear rims, and which are bored to fit and faced on two sides showed the following results:

Bolt circle 42 inches; hub 4⅜ by 7; old time 4½, 4¼, 4 hours; time set, 4; done in 3¼ hours.

Bolt circle 44 inches; hub 5½ by 11¾; old time 5, 5¼, 4 hours; time set, 4½; done in 4 hours.

In this work, as in the case of pinions, the formula: "bolt-circle diameter in inches $\times$ $^1/_{10}$ = time in minutes" gave good results with the limits used in the work.

When I first took hold of the work, the castings were around the machines in piles; now it is hard work to keep the machines supplied. In two instances the night men have been taken off the machines and the day men, with two nights till ten o'clock, keep their work always cleaned up. One man in particular runs a Gisholt machine, getting 24½ cents an hour; he is doing the work of two men now, and averages with his premium and overtime $23 to $25 per week, and his work is never returned on account of bad fits, poor work, or as unfinished. It meets all requirements. This is the class of work he has to do: piston heads, rocker arms, set collars, pipe flanges, cylinder covers, cross heads, all kinds of sheaves up to 20-inch, bronze bushings, and a number of other pieces. If two men worked the machine, each getting 24½ cents and averaging three hours a day premium, it would average $37 a week to the company, but as it is, it runs not over $26 at the most. This is the saving of one machine.

On two Jones & Lamson turret machines, most of the times had been set for bolts of various sizes and some of the studs; shortly afterward the men seemed to make a big improvement on the amount of work turned out. On investigation, I found a change in steel had been made from Mushet to Sanderson. Having a set of tools made of each kind of steel, each was given a fair test; when the operators saw the difference in time of the two steels—nearly 15 per cent. in favor of Sanderson—they made no objection to a decrease in time; both cold-rolled steel and black iron were worked in the test.

Some of the times on these Jones & Lamson machines are indeed remarkable, as they go way beyond the times made by the makers themselves:

	NUMBER PER HOUR.		
	MAKERS' TIME.	TIME SET.	TIME MADE.
Bolt 6 by ⅞, 1½ inches thread, countersunk head....	5	4	10
Bolt 5¼ by ¾, 1 " "	6	5	9
Bolt 6⅝ by $^{15}/_{16}$, 1⅞ " "	7	5	9

The above times set by the shop were made with Mushet steel and medium quality lard oil; on the trial of Sanderson steel, the time was raised one bolt per hour. These are only representative times. Some work done in 10 and 12 hours on these machines is as follows:

22 bolts 1 by 5, 24 1 by 4⅜, 20 1 by 4⅛, 16 1 by 4½, 16 1 by 4, done in 9 hours.
70 bolts 3¼ by ⅞ in 6½ hours.
80 bolts 1 by 4 in 10 hours.
80 bolts ⅞ by 3¼ in 8½ hours.

Studs are also done on these machines; the formula we found for this was:

Length of thread × diameter ÷ 2 = time in minutes for the stud. This was not as accurate as desired, but served to double what was then being done on studs.

On the pinion lathes I found the reverse to be the case—that the Mushet would stand better in a sandy steel casting than the Sanderson. The times on some of the pinions, both shrouded and plain, is something remarkable. One in particular is a heavy shrouded pinion 5½-inch bore and 6½ inches long; the ends of the teeth are turned off at the shrouding from $^1/_{16}$ to ⅜ of an inch on both sides, and pinion is faced on two sides; the time on these pinions was from four to seven hours. The limit was set at four and one-half hours, so as not to discourage the operator. The time he made on those pinions was five in a day of ten hours. It was only after showing the operator how to set and sharpen his tool that this time was made; the time that is being made regularly now is 3½ to 4 a day. By taking a large number of pinions and times, the following formulas were devised to give the man a fair chance to make two hours day for for himself; this was one of the things aimed at, so the men would feel more content to work harder on outside stock, on which no limit had been set:

For a plain steel bore, diameter of bore × length of bore, ÷ 12; for a shrouded steel pinion, the same product ÷ 10.

In some cases this allowed a little too much, but in the main, it comes quite close, for bores from 2 to 6 inches in diameter and 3 to 10 inches long. Here is a small list of pinion sizes, limits, and new times:

OPERATION.		RECORDED TIME.			BEST TIME.	SIZE.	MAT.	TIME. LIMIT.
Bore and face ends including shrouding,	5	5½-3	3-5	4½	2¾	5½ by 5⅞	Cast steel	4
	2		4½	2½	1¼	5½ by 6¾	"	2½
		2½-2	2¼	2	1½	3 15/16 by 7½	"	2
		3	2½	3¼	1	3 15/16 by 7	"	2¼
		2	2¼	2¼	1¾	2 15/16 by 5¾	"	2
	2	1¼-1½	2½	2	1⅛	2 15/16 by 3 15/16	"	2
			4½	7½		6½ by 5⅞	"	3
			4			3 by 7	"	3
		2½	2¾	3¾		3 15/16 by 5	"	3
		2½	5-4			3¾ by 7	"	3
				3.20	1¼	4 by 7	"	2¾
		2.10	3½		1¾	4½ by 7	"	2¾
		2	2¾		1¾	3 15/16 by 4	"	3
	2¾	1.55-1.40		3½	1¾		"	2

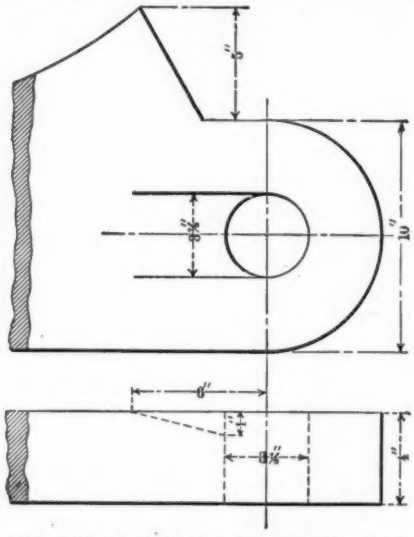
On the shafting lathes, it has been somewhat difficult to obtain fairly accurate times; some of the stock is purchased outside, rough, turned with the centers still on, and the rest is forged in the smith-shop; in both cases the irregularity in the quality of two pieces from the same lot will make from three-quarters of an hour to one and one-half hours difference in the finishing of a piece.

One piece of work in which this shows clearly is the screw for the nut before spoken of; it is of forged steel, 2 feet 8 inches long and 4⅞ inches in diameter, with 2 feet of thread. When purchased outside, it is turned to within $^1/_{32}$ of size; when forged in the smith-shop it is from ⅜ to ½ larger than required size, but I have seen within a short time, a home-forged one and a purchased one follow each other in the lathe; the home-forged took two hours to bring it in shape for the thread, and the outside one two and one-fourth hours. These screws have been divided into four operations:—ends and centers, rough to $^1/_{32}$, finish, and thread. On outside ones, the same but for the roughing, the times are divided thus:—ends and center, ½ hour; rough, 2½; finish, 2½; thread, 2½. When a man has the rough-forged ones, he usually does two a day, while of the outside stocks two and one-half a day is good.

A shipper shaft is about the same; it usually takes four hours to rough one to $^1/_{32}$ and three hours to finish and polish.

For shafting I have no formula or rule, because on different machines it takes different times, and the men feel that if they are not given as much on their machine as someone else is on his, we are trying to cut them. So we try as much as possible to keep one class of work on one machine, but when the variety of sizes in the machinery of two different classes of machines, ranging in capacity from 60 to 100 tons is considered, all being worked at once, the difficulties encountered can readily be seen.

The improvement on the planers has not been very marked; there are only one or two instances that are worthy of note. Planing a slot like this in a steel casting used to take two and one-half to three hours; a limit of two hours made the resulting time one hour. Upon being shown how, the operator did a number in twenty-eight to thirty-two minutes each, but the Sanderson steel would not stand the work; three-quarters of an hour each through the entire day is what is being done, on a 40-inch planer.



STEEL SLOT. PLANING TIME REDUCED FROM THREE HOURS TO FORTY-FIVE MINUTES.

7 by 7 cylinders (double) have taken as long as ten hours to plane, but now on a limit of six hours are being done in four. These pieces have to be set three times—once for the cover and valve seats, and once each for exhaust and live-steam flanges.

On the 90-inch planer, improvement has been made on every piece done; a steel base plate has been reduced from twelve to seven hours, the limit being nine and one-half; in taking a deep cut, very frequently the operator will set his tools tandem, and do the work much sooner by taking in one cut what usually took two.

These last two pieces will do to refer to in respect to drilling; the 7 by 7 cylinders have seventy holes and five stuffing boxes; sixty-eight of the holes have to be tapped; there are four sizes of holes and five settings. The time on these cylinders is four hours, but time and again they have been done completely in two hours, and in some rare cases of soft iron and things just right, have been done in one and three-quarters, which is just one-quarter of what it used to take.

The base plate was a fifteen to eighteen-hour affair. There were some sixty holes $^{15}/_{16}$ diameter, 2 inches through; four holes 2 inches diameter and 8 inches through, and two large holes to be bored out from 2½ to 3 inches through 5 inches. All these holes are cotter-faced

on the other side. The working of this piece was made up to fourteen-hours limit; it is strange if it is not done in ten hours now.

These are just sample cases of what has been done in the drilling; it has been so in nearly all cases, although the timing on drilling was set principally from standard tables, and not from actual work.

The changing of a jig or the making of a double jig has made some very great improvements in drilling; links furnish an example. They are ½ inch and ¾ inches thick and have a $^{13}/_{16}$ hole drilled in each end; they are of bar steel. Two hundred a night was considered a night's work, but by two jigs, on a sliding base, on another drill, they are being done at the rate of thirty an hour, on a limit of thirty-five.

I will now take a piece through the shop from stock to finished piece, and show the improvement on it. The example will be a cast-steel base plate weighing nearly 4 tons; it goes first to the planer and has the bottom planed, then to horizontal boring bar to have hub turned, to horizontal drill for four pin holes, which takes four settings; the holes are bored to 3½ by 8 from 3 inches; then it goes to the radial drill for the finishing drilling.

	Planer.	Horizontal Boring.	Horizontal Drill.	Radial Drill.
Old Time, hours	12	14	12	16
Time Limit "	9½	10	9½	14
New Time "	7	7½	7	10

A 10 by 14 engine bed goes through the same process except for babbiting.

	Babbit.	Planer.	Horizontal Boring.	Horizontal Drill.	Radial Drill.
Old Time, hours	5	7	14	3½	4
Time Limit "	4	6	11	3½	3
New Time "	2½	4¼	7	3	2

The result of the improved time in all departments is the decrease of one and one-half to two days' time in the erection of a machine, which is no small item when one machine a week is called for, besides other work going on at the same time.

Of things that I have noticed, just a word. If a man has a finished piece to remove from his machine and does not find a helper handy, rather than run all around and look for one, he will take the piece out himself or ask anyone near to loosen up the chuck and tail stock and then lift it out himself.

The men pay stricter attention to work, as a minute lost is hard to gain.

Their fits, in comparison to some of the men who do not earn premiums, are far better, and they turn out a better class of work.

Each man is very careful to measure up a piece left in his machine by a night man, and the least error is reported, thus making each man an inspector on the other man's work. The fear of each man is that if the other has made a mistake, premium time on that piece would be taken from both when the error was found by the inspector.

The improvement in time for the machine department is from fifty hours a week when first started to two hundred and sixty just a short time ago; very shortly for the entire shop seven hundred hours a week will not be uncommon.

The pull on the machines is felt in the power house, and has made the ammeters rise from 200 to 500, which is not a very bad showing.

The premium system gives a more accurate time on work for cost purposes than the time ticket made out by the men; on the time ticket, waits for certain tools and frequently machine repairs are charged up to the order number in the machine at the time, whereas on the premium time they are made separate items. The premium for each day is stamped on the workman's time slip by the premium clerk before the tickets are sent in to the time keeper.

So much for the premium system, for the shop and the man; and so long as the man is treated squarely, so long will the premium system prosper in the shops.

LIQUID FUEL FOR POWER PURPOSES.

By Arthur L. Williston.

Professor Williston's article represents probably more actual experience with the mechanical aspects of the use of liquid fuel than any other contribution which has yet appeared. It embodies the results of several years' successful practice in an institution which has been working steadily along this line, and also the results of the experimental work of one of the largest corporations interested in the problem. And the illustrations, like the text, represent actualities, and not theories. They are taken from installations in which the problems have been worked out to a successful conclusion under the conditions of daily work and average conditions. In view of the rapidly increasing use of liquid fuel and the economic changes which will result therefrom, this article has unusual importance. The economic side of the question will be discussed by Professor Williston in a succeeding article.—The Editors.

THE use of crude oil or petroleum as a combustible under steam boilers has long been a fascinating subject for engineers and steam users. The ease with which such fuel can be handled and controlled; the freedom which it gives from dirt and smoke; and the thermal advantages which it possesses over other kinds of fuel, have made it a most desirable substitute for coal wherever and whenever economic and commercial conditions would permit its use. Until within a short time, however, the comparatively limited supply and the difficulty in the way of its cheap transportation from the oil field have prevented its extensive use, and only in the most favored localities have manufacturers been able to burn it to advantage for power purposes.

In 1887 the Pennsylvania Railroad, in its efforts to improve its practice in the direction of fuel economy and to decrease the burden that the heavy annual payments for coal place in the way of cheap transportation, made a careful series of tests on oil burning. Oil had, even at that time, been extensively used in Russia for locomotive fuel, and the officials of the Pennsylvania Railroad were able to profit by the experience of the Russian engineers, so that they had little difficulty in getting satisfactory results from the oil so far as combustion was concerned. In fact, the official reports of the tests show that the oil burning was an ideal method of firing, easily regulated and always under perfect control. It gave absolute freedom from smoke and cinder, and, at the price of oil which then prevailed, it was thought that there would be, on some parts of the system, a slight economy

as well, when all things—especially the handling of coal and ashes and the cleaning and repairing of the locomotives—were taken into account.

But the road on all its branches was then using about 8,000 tons of coal per day, or an equivalent of 52,000 barrels of oil per day. It was estimated that if any considerable portion of this amount of oil were to be used it would so enhance its price, in accordance with the laws of supply and demand, as to make any advantage of the oil burning disappear. The idea was therefore, for the time, abandoned.

Some five or six years later the Chicago, Burlington & Quincy Railroad made a similar series of investigations, but at that time the relative price of oil and steam coal was such that those in charge decided that a change was not desirable. They came to the conclusion, too, that if they were to use oil as locomotive fuel over the whole system, they would need about all the oil that was being produced at that time.

During this period, when the price and the limited supply of oil made it undesirable for locomotive fuel, there were some manufacturing plants that were so situated that they could use oil under their boilers with economy, and because of the advantage from a military point of view, numerous experiments in oil burning were being carried on by several of the naval powers, but its use did not become at all general. Recently, however, the discovery of new oil fields so extensive that there is good reason to believe that the oil wells will not be soon exhausted, and that there is an assured supply to meet the demands of the future; the construction of pipe lines which very materially reduce the cost of transportation; and the high price of coal which has prevailed in many manufacturing districts, have combined to give a new argument for the burning of crude oil for power purposes. And it is probable that during the past two years there has been greater increase in its use than in all the previous time since mineral oil was first discovered. Already some manufacturing plants in the eastern States, which formerly have been dependent on the coal fields of eastern Pennsylvania, have found themselves able to obtain a cheap supply of crude petroleum, or refuse oil, and are burning it under their boilers. A number of vessels, also, in the American merchant marine have been fitted, in the place of the usual coal bunkers, with tanks for the storage of the oil with which to feed the burners that have been placed under their boilers; and many others are anxiously awaiting the results of these experiments, ready to make similar installations if these continue to prove satisfactory, or to make improvements upon them as experience may suggest. Experiments of the United States Navy in

this direction, too, have already warranted the Bureau of Steam Engineering in recommending that on at least one-third of the torpedo boats and torpedo-boat destroyers, liquid-fuel installations should be effected without delay; and a Board of Tests of Liquid Fuel for Naval Purposes, authorized by Congress, is at present conducting an elaborate series of tests to determine the best conditions for oil burning on all classes of vessels, including the armored cruisers and battle-ships.

These facts will give some appreciation of the interest which is now being taken in many sections of the eastern States in oil as a source of power; but in the western and southwestern States, where steam coal has always been both scarce and poor in quality, and where the question of transportation from the new fields in Texas and California has been less of an obstacle to the installation of oil-burning equipments than has been the case on the Atlantic coast, the interest is even greater and the use of oil has become far more extensive. In California oil is rapidly driving coal out of the field for power purposes, throughout the State. The same is true in Texas, and of much of the territory lying in between. This general use of oil has affected not only the power and lighting and manufacturing plants in these regions, but also the railroads, and marine transportation as well. With the relative economy, at present prices, between the oil and coal varying from one-eighth to one-half or perhaps less, according to the cost of transportation from the wells to the different points where the oil is consumed, this unusual development is not surprising and the use of liquid fuel for power purposes is still rapidly growing.

One railroad operating in California is now burning oil on more than one hundred and eighty of its locomotives. Another of the great transcontinental systems is already using oil on about five hundred of its locomotives—which is 30 per cent. of the total number operated by the system—and is equipping others as rapidly as possible. In addition to the use on locomotives, it is using oil on its steamers in San Francisco Bay, and on its river steamers, with very good results.

These few facts are, I believe, sufficient—if, indeed, anything were really needed—to show the very rapidly growing importance of liquid fuel as a competitor for coal; and to remind every mechanical engineer and steam generator of the significance and value of whatever may help in determining the conditions or appliances with which the best results from oil can be obtained, or the relative economy that may be expected from coal and oil burning in any given market.

This whole question is so large, and it involves so many elements—chemical, mechanical, and economic—that there are many problems

still to be worked out, and there are many lines on which further investigation is necessary. The experience has thus far been short and more facts are needed. Nevertheless, considerable data have been collected regarding the practice, and some points have already been settled with a considerable degree of definiteness. It is to discuss some of these things that is the purpose of this paper.

In the early attempts to use oil as a power fuel it was introduced into the furnace in bulk without air or steam and without any attempt to atomize it. It was simply allowed to vaporize from iron plates or from the incandescent surfaces of brick or stone within the furnace. With this method of introducing the oil, forcing the fires was manifestly impossible, as the vapor thus given off could be burned only as fast as it was formed and the vaporization was limited by the extent of the surface exposed.

It seems to have been pretty definitely settled now that better results can be obtained by introducing the oil in the form of a finely divided spray by means of an atomizer; and, so far as the mechanical part of the problem is concerned, it may be said that the greatest difficulty was overcome when it was first realized that the success of oil burning depended largely upon the efficiency obtained in atomizing the fuel. With the oil sprayed under the boilers in this way, it has been found that the fires can be forced at will—even to a degree beyond that which is possible with coal under forced draft. The rate of vaporization and the combustion of the oil are limited only by the size of the burners and by the velocity with which the air and products of combustion can be forced through the furnace.

Burners.—Both compressed air and steam have been successfully used as the atomizing agent, and the majority of the burners now on the market are designed with the openings adjustable so that they may be used with either. Most of these are patented devices, and a very large number of them have been brought out. The activity of the inventors in this direction can be judged from the statement made in the preliminary report of the Liquid Fuel Board, that new patents for liquid-fuel appliances were being issued in the United States at the rate of thirty a week. Nevertheless, there is great similarity in principle and in action between these different burners, and therefore for our present purpose it will be necessary to describe only two or three typical ones.

Figure 1 shows a section of the Reed burner, which has been extensively used with good results. The oil is admitted through the small three-eighths inch pipe in the center, and the steam used to atomize

it enters through the annular chamber marked A. The size of the opening through which the steam flows may be varied by turning the sleeve B either to the right or to the left, and thus moving the casting C backward or forward. The stuffing-box D is needed to prevent the steam from leaking at the back end of the burner. A limited quantity of air is admitted through the center of the burner, as indicated at E. This air has good opportunity to become thoroughly mixed with the steam and the atomized oil as it is forced into the furnace, and thus helps the combustion. It is not, however, essential to the action of the burner, and it is probable that the oil would be just as perfectly atomized if it were not present. In fact, many burners now on the market are designed without this provision, and consist only of the inner tube for the oil and the surrounding annular passage for the steam or compressed air, whichever may be used as the atomizing medium.

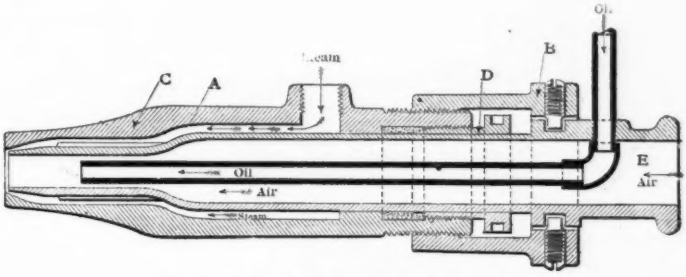


FIG. 1. SECTIONAL VIEW OF REED BURNER.

The chief virtue of this burner is its simplicity and the fact that it thoroughly atomizes the oil. Many other burners have additional features tending to give the spray a rotary or whirling motion as it is forced into the furnace, or to mix it more thoroughly with the entering air by variously shaped tips. But experience has shown, so far as I am aware, that such features only complicate and make the burner the more easily clogged by dirt or deposited carbon, and that they do not really add to its effectiveness in atomizing the oil into a finely divided spray. This seems to be the only criterion by which the efficiency of a burner should be judged.

Figure 2 shows the top view, end view, and section of another type of patented burner which is used extensively on one of the railroad systems of the western United States. It differs from the one just described only in being rectangular in section, thus making possible the use of larger openings through which the steam may be forced at

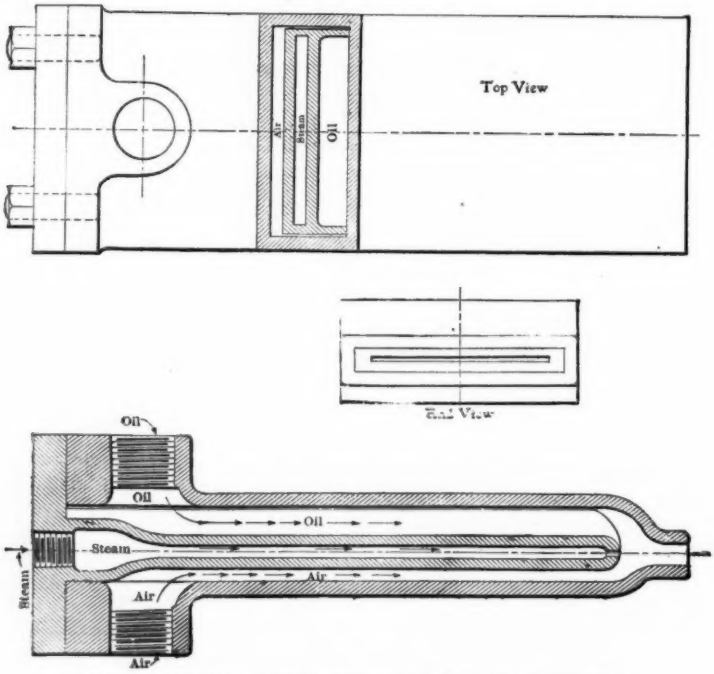


FIG. 2. TOP, SIDE, AND END VIEWS OF BURNER FOR LIQUID FUEL.

high velocity, than could be had in a burner of circular cross section like the Reed burner. In a circular burner, if the diameter of the openings were increased beyond a certain point, the steam or compressed air could not come into intimate contact with all parts of the oil jet as it entered, and the efficiency of the atomizing effect would be lost. But in the burner shown in Figure 2 it will be noticed that the oil as it enters flows in a thin sheet over the steam passage, and as it falls comes directly in contact with the wide jet of steam as it emerges from the rectangular opening. There is another good feature in the design of this burner which should be noticed. The oil as it enters passes over the top of the casting forming the steam chamber, becoming more fluid as it is heated, and therefore more easily atomized.

Air *versus* Steam as an Atomizing Medium.—A difference of opinion exists as to the best medium for atomizing oil. Both air and steam have been used with excellent results, as has been already stated. But it is difficult to say positively which is the more economical.

In large plants—or in small ones where a supply of air at pressures of from 2 to 5 or 10 pounds per square inch is available—air is unquestionably more economical than steam, so far as the spraying of the oil is concerned. Where it is necessary to use air at higher pressures, the difference in economy is not so clear, as the cost of each cubic foot of compressed air increases rapidly as the pressure increases, but its ability to atomize oil does not increase at anything like the same rate. The most economical results obtained from the recent tests of the United States Navy are with air at between 1 and 2 pounds pressure per square inch with the Oil City Works air burner; but not all burners would work with air at this low pressure. Weighing the steam that was used to furnish the compressed air, it was found in these tests that less than 2 per cent. of all the steam generated in the boilers was necessary for atomizing the oil with the air pressure between 1 and 2 pounds, while 4 per cent. of the steam generated was found to be needed when the air used for atomizing was at a pressure of 4 or 5 pounds per square inch.

There is, too, another advantage of using large quantities of air at low pressures, arising from the fact that all the air thus introduced into the furnace helps in the combustion of the fuel and reduces the chances of small amounts of vaporized oil passing up the stack unconsumed. Steam, on the other hand, when it is used for atomizing, tends to dilute the air which is needed for combustion as it enters the furnace. This, of course, is undesirable. The smaller quantity of steam used, therefore, the better from this point of view, as well as from the standpoint of steam economy.

With a burner having its steam and oil orifices properly proportioned, it is therefore probable that the highest efficiency can be obtained with the steam at full boiler pressure, although further experiment is still needed to establish this point definitely. The experiments available show that from 5 per cent. to 6 per cent. of the total steam generated may be necessary for the burners when steam is used instead of air.

In this connection it may be well to add a few words regarding the action that this steam has in the furnace, for this is a matter that is very generally misunderstood. It is often supposed that because the steam takes part in the combustion chemically, it adds something to the heat generated, but this is not the case. Its effect is only to dilute the products of combustion in the same way that the nitrogen of the atmosphere does, and in a similar manner, too, it carries a certain amount of heat with it up the stack. It is true that the steam is

wholly or partially decomposed on reaching the hottest part of the furnace and, if there is not sufficient air at that point, it gives up part of its oxygen to the carbon in the oil, leaving free hydrogen. It follows the same reaction here that occurs in the production of water gas. If a sufficient supply of air is admitted later, however, this hydrogen is all burned before it leaves the furnace, but the amount of heat developed thereby just balances the heat that was absorbed by the decomposition of the steam, so that there is neither a gain nor a loss of heat produced by this chemical action, unless some of the hydrogen escapes up the stack unconsumed.

Its only effect on the fire has been to subtract heat from the furnace near the burners, thus decreasing the intensity of the fire at that point, and later to add just the same amount of heat to the combustion farther away from the point where the oil enters. Practically, then, the effect of this steam is simply to add to the length of the flame and to carry it farther back into the furnace than it would otherwise go. This is often of very great value, as it prevents the intense local heat at one point which is likely to cause most injurious local expansion strains in the boilers, and it tends to give to all parts of the heating surface more nearly the same efficiency that the heating surface within the fire box usually has. So far as the total heat available for evaporation is concerned, however, its effect is, as has already been stated, almost exactly the same as an equal amount of nitrogen in the entering air.

Pre-Heating the Oil.—Fuel oil may be successfully sprayed into a furnace at the temperature of the boiler room, but this can be much more readily accomplished if the oil has been previously heated before coming in contact with the compressed air or steam. In the description of the burner shown in Figure 2, which was designed for locomotive use, attention was called to the way in which the pre-heating was done in that instance. This method is satisfactory for railroad use, but for stationary boilers it is usual to adopt a somewhat different method which can be more fully controlled.

Figure 3 shows such an oil heater in front of the boiler setting. This heater consists of a short piece of 6-inch or 8-inch steam pipe, capped at both ends, through which a long coil of small steam pipe is passed. The oil enters at the bottom, flows up around the hot steam coil, passes out at the top, and on to the burners.

The temperature to which the oil should be heated will vary with the character of the oil, a heavy, sluggish oil requiring a higher temperature than a light, volatile oil. For most oil used for fuel pur-

poses, however, the range will be from 180 degrees F. to 220 or 240 degrees F. In no case should the oil be heated hot enough for any considerable portion of it to be vaporized before it reaches the burner, as this would interfere with the atomizing process; but so long as this condition is not reached, the higher the temperature to which the oil is heated the better, as the warmer it is the more fluid it becomes and the more rapidly it is vaporized after leaving the burner.

The Furnace.—The proper design and construction of the furnace is of the very greatest importance in its effect on the efficiency of the oil-burning plant; and, just as the burner was found to be the key to the control and regulation of the fire, so the furnace more than all else determines the efficiency of the fuel combustion. The furnace design, therefore, will be controlled by the requirements for perfect combustion. And these requirements for perfect combustion are very simple. They are: *That every particle of fuel shall come in contact with no more and no less air than it theoretically needs for its complete combustion;* and *that it shall come in contact with this air before it reaches a part of the furnace which is below the temperature of ignition.* Therefore, there are three ways in which the furnace may fail of perfect efficiency.

1. It may supply to some of the fuel more air than is needed, wasting heat by increasing the temperature of air which does not take part in the combustion.
2. It may supply to some of the fuel less air than is needed, thus allowing some fuel to pass up the stack unconsumed.
3. The temperature in parts of the furnace where the air and the fuel come together may be below the temperature of ignition, which means that that fuel will be unconsumed.

In designing a furnace all of these conditions must be carefully considered and, if possible, fully met. The realization of them is far less difficult with liquid fuel than it is with any form of coal, and the experience of the last few years has clearly demonstrated that perfect combustion can be very nearly reached with almost any burner, provided proper care is taken in the furnace design; and without this, I am convinced that it is impossible for any burner to burn oil efficiently in large quantity. In a small flame it might be possible for the oil vapor to be so uniformly mixed with exactly the right quantity of air as to form a *true explosive mixture* that would give instant and perfect combustion throughout its mass. This condition may be very nearly met in the small flame of a hand blowpipe, but with the large burners that are necessary where oil is used as fuel under the

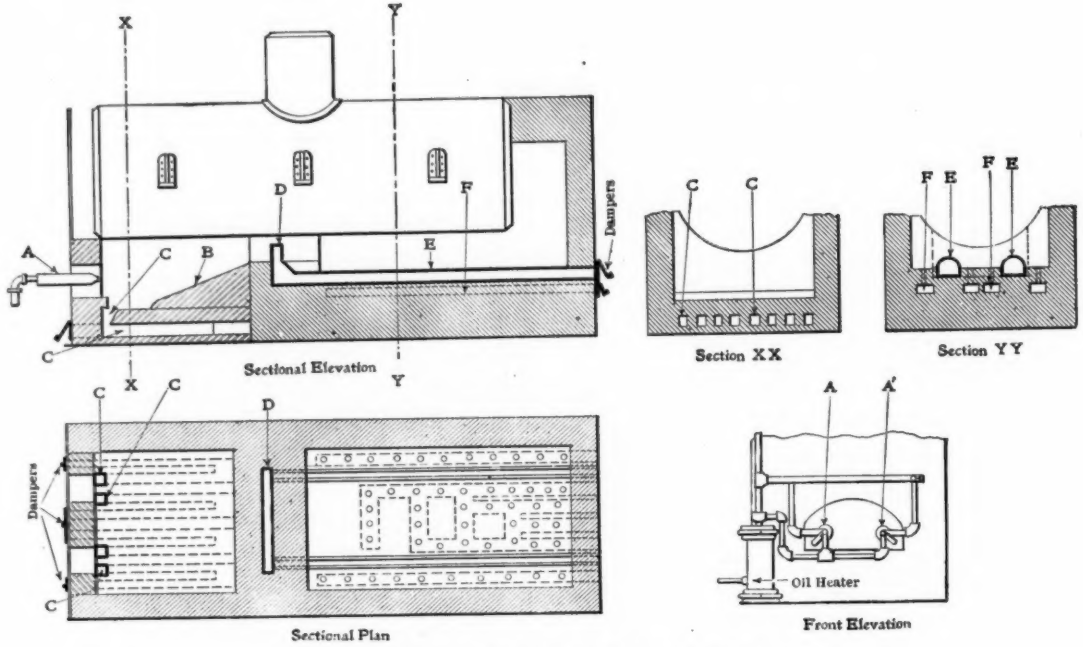


FIG. 3. OIL-BURNING FURNACE FOR MULTITUBULAR BOILER.

Scale ·½ inch equals 1 foot, approximately.

boilers this is not possible, and no burner has ever been constructed that will accomplish that result.

In the practical problem of burning oil on a large scale, *time* is required for all the oil to be completely vaporized and for this vapor *all* to come in contact with the air which is needed for its combustion. It is therefore necessary to have a very considerable volume to the flame and a combustion chamber where it can be confined until the chemical action is complete.

No burner yet devised can spray oil at all times with perfect uniformity, or evenly mix it with the air as it enters the furnace, so it is necessary either to admit more air than is really needed with the oil, or else to admit small additional quantities at different points in the furnace for the combustion of any fuel that might otherwise escape unconsumed. This latter method has been found to give by far the most satisfactory results, and with it the fires can be regulated with great nicety. This additional air should be admitted at points in the furnace where the temperature will be sure to be above the point of ignition, and also where there is a good circulation in the products of combustion, so that it will be sure to meet any unconsumed oil vapor. In this way the fuel may be completely consumed with practically no excess of air. When oil is used as a fuel, therefore, it is necessary to design a furnace of sufficient size to allow time for the complete combustion of the atomized oil before it leaves it. The furnace should also have provision for admitting the air needed for perfect combustion at different points, and it should be so designed as to maintain in every part a very high temperature.

Figure 3 shows the construction of one of the furnaces for a battery of multitubular boilers 6 feet in diameter and 18 feet long. The oil is admitted through two burners, A and A^1; which are placed in holes drilled through the fire door. These burners are set so as to direct the flame against the fire-brick incline, B. A limited amount of air is admitted with the steam and oil through the burners, but additional air is supplied to each burner through the four openings marked C. As the flame passes over the bridge wall, more air is admitted through the long, narrow opening marked D. All along the bottom of the chamber between the bridge wall and the rear of the furnace setting there are a large number of very small openings through which additional air may be admitted to the flame as it is needed for perfect combustion. All of these different sets of air openings are furnished with dampers which may be nicely adjusted so as to admit just the quantity of air that is needed in each part of the furnace.

Mica peep holes are provided at different points in the setting, through which the fireman can watch the flame in every part of the furnace, and with very little practice he is able to adjust the air supply as he varies the quantity of oil burned, so as to get perfect combustion with almost no excess of air. Under these conditions it has been found with this furnace that the whole setting will warm up to a uniform temperature and that the entire furnace, including the mixing chamber at the rear and its walls, will become perfectly transparent and very bright red in color. A slight change in the air supply above or below the proper amount, however, will disturb this transparency, so that the fireman has had no difficulty in nicely regulating the combustion. With the dampers rightly adjusted, the products of combustion are entirely free from color and odor and, running the plant from September to June, the flues are found each June as clean as they were when the boilers were started up in September. After this setting is uniformly heated, it will maintain its temperature for a long time, and at night it has been found that the oil could be turned off thirty minutes before the engines were shut down at the time the plant was carrying its heaviest load, and yet the heat given off by the boiler settings was sufficient to do the required work with no perceptible falling off in boiler pressure, and that during the night, with no fire whatsoever, the pressure would drop only about fifteen or twenty pounds before morning.

Referring again to Figure 3, it will be noticed that all the air that enters the furnace has to pass through long, narrow passages of hot fire-brick or tile. This, of course, helps to maintain the uniformly high temperature necessary for perfect combustion. The passages that lead to the four openings, C, are made by leaving spaces between the fire brick which are laid in the space that would ordinarily be used for the ash pit. This brick, after the fire has been started, becomes very hot and, as the openings are small and the passage of air correspondingly slow, the air has a chance to be well heated before it reaches the flame at the burners. The two passages that lead to the opening in the bridge wall, D, are made of D-shaped tile (marked E in Figure 3) which project upward into the furnace so as to expose as much surface as possible to the flame. The large number of openings in the space between the bridge wall and the rear of the setting are made by making a small V-shaped nick in each brick, thus connecting the furnace with the passages below, marked F, which lead to the rear of the setting where the controlling dampers are placed.

The flame as it enters the furnace is directed against the incline in

front of the bridge wall in such a way as to cause strong eddies and currents which bring every part of the flame close to these air openings at the bottom of the furnace; and, as the setting is continuously incandescent, ignition of any unconsumed oil vapor is sure to take place even with a minimum air supply.

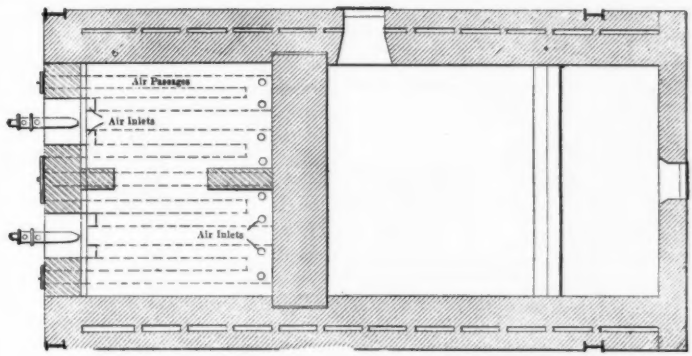
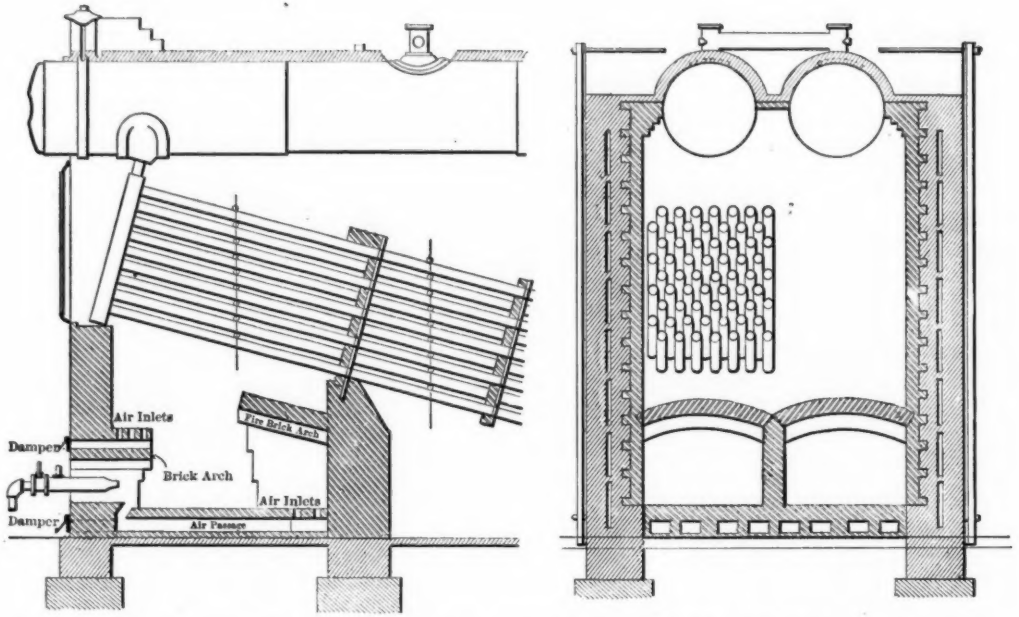


FIG. 4. PLAN OF OIL-FIRED BABCOCK & WILCOX BOILER SETTING.

Figures, 4, 5, and 6 show the plan, longitudinal section, and the cross section of a furnace designed for a 250-horse-power Babcock & Wilcox boiler so as to accomplish these same results with the water-tube boiler. Here there is not the same opportunity that was had in the previous case to have a long combustion chamber virtually running the whole length of the boiler, so that extra precautions have to be taken to insure perfect combustion before the flame reaches the tubes. This is accomplished by means of a fire-brick arch which causes the flame to return on itself before it has a chance to be chilled by the water surface of the boiler. In this furnace, too, there are air passages which admit pre-heated air to the flame at various points. This air enters through the regulating dampers near the floor and passes under the hot fire-brick which forms the floor of the furnace back to the bridge wall, and returns again to the two air inlets underneath each burner. There are also small air inlets near the bridge wall and underneath the main fire-brick arch, through which small amounts of air may be admitted, and there are also still other inlets, for air which is admitted through the small, hollow fire-brick arch at the front of the furnace.

In this furnace the same results are reached as in the design for the furnace of the multitubular boiler which was previously described. Air, in addition to the amount admitted through the burners with the



FIGS. 5 AND 6. PART LONGITUDINAL SECTION AND CROSS SECTION OF BABCOCK & WILCOX BOILER ARRANGED FOR FIRING WITH LIQUID FUEL.

Scale 3-16 inch equals 1 foot, approximately.

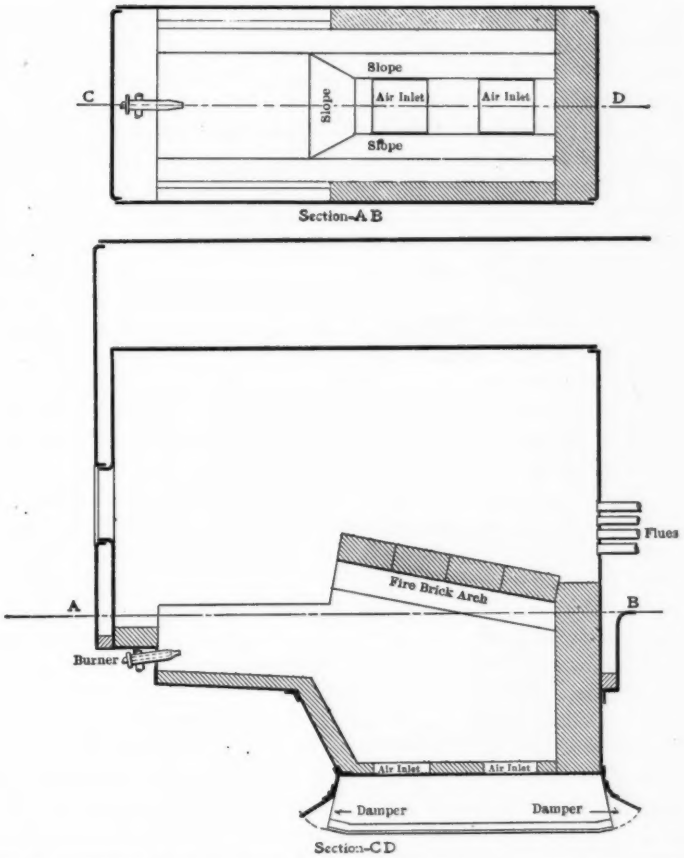


FIG. 7. SECTIONAL PLAN AND ELEVATION OF FIRE-BOX OF OIL-BURNING LOCOMOTIVE.

Scale ½ inch equals 1 foot, approximately.

oil, is admitted just in front of the burners, again at the bridge wall, and again just before the flame reaches the tubes, and in each case it is admitted at a point where there is an excellent circulation in the products of combustion. A very large surface of incandescent fire-brick is also present to insure ignition of every particle of combustible. This furnace is 7 feet deep and, as the drawings are made to scale, the other dimensions can readily be inferred from the proportions.

The advantages of heating the air which is needed for combustion

are almost too obvious to call for comment. Heat which otherwise would be lost by radiation is in this way saved, and the flame is not exposed to the chilling influence which is exercised by a draft of air entering upon it. Wherever it is possible it is therefore desirable.

Figure 7 shows a sectional plan and sectional elevation of a typical locomotive fire-box as fitted for oil burning by one of the railroads which consume oil most extensively. The idea and purpose of the fire-brick lining and fire-brick arch inside the fire-box is precisely the same as in the furnace for the Babcock & Wilcox boiler just described. There is not here the same opportunity to heat the air before it enters the furnace that there is with the stationary boilers, but it will be noticed that the air is admitted not only at the burner but at the bottom of the fire-box under the fire-brick arch in such a way that it can be accurately regulated by dampers, and also that there is a large surface of incandescent fire-brick exposed to the flame. The fire-brick arch also serves to protect the tube sheet from the intense heat to which it would otherwise be subjected.

The fire-box shown in Figure 7 is about 8 feet deep measured to the tube sheet, but on some of the locomotives having still deeper fire-boxes there is a fire-brick wall—with the fire-brick arch in front of it—placed about 6 feet from the burners, leaving a space for a combustion chamber between this wall and the tube sheet. On some of the locomotives, too, there is a small arch placed over the burners, like the one shown in the furnace for the Babcock & Wilcox boilers, to confine the flame further and to protect the fire-door. Otherwise the arrangement of the fire-box is similar to that shown in Figure 7.

The great variation in the price of oil in different parts of the country makes it difficult to say when a saving can be effected by the use of oil as a substitute for coal. This is a problem which will have to be worked out separately for each locality, and the solution will depend not only on the supply at the nearest wells, but also on the distance from the oil fields and the facilities for transportation at hand. The engineer who is contemplating an oil installation, therefore, will have to consider these things just as carefully as he considers mechanical advantages and savings in labor and repairs, when he is comparing the relative economy of oil and coal for power purposes.

LABOR'S COMPLAINT AGAINST CAPITAL.

By Frederic Hay.

It is quite safe to say that the labor question can never be settled from one side alone—and with all deference to the discernment and the sincerity of those who are seeking as representatives of the employer to put themselves in the employee's place, there is nothing quite so profitable for enlightenment as to hear from the employee himself. Mr. Hay's contribution comes so late that it can not be placed in the logical position near to Mr. Cokely's. It must be allowed to sum up the number which the other article opens. But here it may be most effective in urging again—as Mr. Cokely does so earnestly throughout his paper—as Mr. Kimball does in his conclusion—that labor will never be satisfied and *should* never be satisfied until it is met with larger justice and larger opportunity to increase its earnings than has generally existed heretofore.—THE EDITORS.

THE frequent manifestations of discontent and unrest in the ranks of the many branches of labor, voiced through the medium of their organizations, should it appears to me indicate to the intelligent mind that there must be deep-seated causes for the trouble that will not down.

In the article by Mr. Carpenter in the April number of THE ENGINEERING MAGAZINE, on "The Working of a Labor Department in Factory Management," the subject is dwelt on at great length, and the cardinal point is made, perhaps more forcibly than logically, "that the time to stop trouble is before it begins." That I think may be accepted as an axiom. But the question arises *how to prevent it?*

From the standpoint of the employee (to which class I belong) I feel that while, theoretically, Mr. Carpenter's propositions may seem all that is required to "stop the trouble before it begins," yet they do not practically represent the actual conditions that would be satisfactory to the wage-earner. Workmen are averse to the referring of questions to departments, with the delays consequent upon investigation; nor does Mr. Carpenter indicate the *materiel* of which the Labor Department should be composed, which would be a matter of consequence in the event of his suggestion meeting with approval.

Workingmen, as a rule, are not broad-minded or far-seeing; their minds do not in general range beyond their particular trade, and their party politics. They are suspicious of their employer, believing that any new method introduced is to beat them in some way to the employer's advantage. Labor-saving devices generally do not meet their approval; the time-clock especially is looked on with contempt as an

invention designed to make further profit out of them; and many men think it creditable to use the means in their power to get even with it—and they do, too.

The existence of labor unions in the present day is in itself great evidence of the unwillingness of employers to concede to their workmen what they believe to be a fair share of the earnings acquired by their industry and skill. The unions were not at their inception designed as a menace to the employers but, as descendents of the Guilds of the Middle Ages, associations of trained and competent workmen for the conservation of their rights, and to secure a uniform wage in their various trades—so that to be a member of a labor union is to imply a competent workman.

Labor is more necessary to capital than the latter to the former (though this may not generally be conceded)—without labor capital could not be employed to advantage. Men need not become mechanics.

No special system can be devised to meet all cases, because all men are not alike—there are the zealous and the careless; the industrious and the idle, *i. e.*, the worker and the fakir. The most successful system in the long run will be that which appeals to the men's honor—and to that alone. The men should by a careful and quiet process of weeding be brought, as nearly as possible, to an equal standard.

One reason for the indifference of the workman to the interests of his employer is the drifting apart that has for years been going on. In former times (not so many years ago) the employer was interested in his men. He had been one of the craft himself. His face was seen in the workshop or factory. He knew the men by their first names. He knew something of their condition and their needs. The men could address him personally if they would.

All that is changed now. These are days of large combinations of capital. The capitalist does not require a practical knowledge of the business. He is not in sympathy with the "hands," with whom he holds no communication, should he ever see them, and so the superintendent takes the place which the employer formerly held.

As the object of business is to obtain the largest return on the capital invested, the duty of the superintendent is primarily to produce that return to his employer by restricting the working expenses to the lowest point. On all questions that may arise he is practically the court of appeal. The employer does not desire to be troubled with the affairs of the "shop."

The foreman comes between the workmen and the "super," as he is known in the shop, and controls the working department. He should

be a first-class workman, knowing to a hair what it is possible for the men to do—a man of firm but equable temper, just to employer and men alike, easy of approach—and should strive to preserve order and content. The average foreman does not in my experience represent these conditions. He requires an homage paid to him akin to that of a sovereign; he resents appeals from his decisions, just or unjust; and if a man dispease him, no matter how good a workman, he may expect discharge.

One open cause of discontent on the part of labor is the undisguised hostility on the part of capital. The employer objects to deal with labor's only representative—the union. But objectionable as many features of the union are (and the ranks of labor are aware of them), it is their only protection; through its means have been obtained advances of wages and reduction of hours of labor; it is their bundle of sticks, and for their mutual interests forbearance should be shown by each. After a bitter contention sometimes a slight advance in wages may smooth over the surface for a while; but the discontent remains. That for which labor is contending and without which it will not rest and be satisfied is:

Recognition by capital as a factor in the production of profit. The workman sees his employer grow rich, while his income does not advance; his dollar has not the purchasing power of a few years ago, for the things he needs, and if he have family, his mind is exercised how to maintain them properly. He asks himself questions: Why should he toil so many hours a day and be expected to do so much; why when the business is prospering he enjoys no benefit, though if it be dull he may be expected to take three-quarter time; why, when there are legal holidays he should be "docked" his pay and the foreman be paid; and lastly, for the three months' Saturday half-holidays he should lose half a day each week, when he knows that by pressure he has been made to earn his full week's pay? The holidays, instead of being cause for rejoicing, are the reverse.

If the workmen were treated more as helpers to their employers' prosperity and made to feel that their efforts would be recognized—that when the accounts for the year's business are made up a bonus or percentage of profit would be awarded them, discontent would give place to satisfaction and honest pride in their work.

The views expressed in this paper may not be acquiesced in, but they are not theories; they are the results of experience, and in my opinion it is for their mutual welfare that capital and labor should approach each other with recognition of their mutual interest.

EDITORIAL COMMENT

THE present greatly disturbed condition of the relations of employers and workmen is more than sufficient justification for the space given to labor questions in this number. We are glad to be able to present the subject from so many points of view as can be obtained either from the direct arguments or the *ob ter dicta* of Messrs. Cokely, Hay, Colwell, Kimball, and Buchanan. It is not strange that there should appear, in these several presentations, wide differences of opinion. Mr. Hay advances some views for which employers will have scant tolerance. Mr. Colwell describes certain features of practice which labor leaders will bitterly attack. The essential thing, however, before any adjustment can be hoped for, is that each party shall see that there is another side and shall understand what that side is. Beyond that, the way to solution lies by infinite patience and long striving after common sense on the part of the wisest of leaders both of capital and of labor—by the long exercise of that "voluntary human restraint" which Mr. Cokely upholds in his opening article as the source of all that is best in the world.

* * *

AN example of the false attitude too often assumed by organized labor toward methods for remunerating men in proportion to their productive capacity, is shown in a recent strike at a Rochester shop where the premium plan has been in successful operation for more than two years. Its abolition is demanded, as plainly stated by the labor representatives, because the incentive offered by the system causes the men to increase their output as well as their pay, and this condition is "*not favorable to organized labor.*"

The machinists who are working under the premium plan at the Davis shops are stated to be themselves well satisfied; the opposition comes from the union outside, under the advocacy of other members working in shops where the premium system is not in use. This is the sort of interference which Mr. Cokely well says is intolerable.

The aim of the union is distinctly restriction of output to that of the capacity of the slowest workers, based on an acceptance of the theory of the "lump of labor" and of the idea that any increase in the productive power of one man decreases the opportunities of his comrades. That whole theory has been proved in the long run absolutely false. It is hard to see how anyone can cling to it after even the most casual glance at the history of industry. It is true that certain transitional periods have borne heavily on the superseded orders of workers. The shock of change fell most heavily on those least able to bear it. In lesser things, the daily wage worker, though his resources in emergency are least, is still subject to unforeseen changes of circumstance shocking in their suddenness and violence. With the minimum reserve against failure of income, he has the minimum assurance of its continuance. It should certainly be the earnest and conscientious care of employers to avert the disasters of this condition from their employees.

But no such results attend the gradual increases of production secured by modern methods. They are indeed necessary, and at the utmost are behind the constant increase of consumption. And the vital force of most of them is the stimulus of competition. When combinations to restrict competition are effected by capital, they are denounced by labor and checked by the courts as being "in restraint of trade." But when they are forced upon ambitious workmen against their will by the representatives of organized labor—what then?

* * *

THE brief paper of Mr. Frederic Hay, which will be found elsewhere in this issue, contains some interesting side lights upon labor matters which will bear further examination. Thus, Mr. Hay says: "If the workmen were treated more as helpers to their employer's prosperity and made to feel that their efforts would be recognized—that when the accounts for the year's business are made up a bonus or percentage of profit would be awarded them, discontent would give place to satisfaction and honest pride in their work."

It is, according to Mr. Hay, for this and similar purposes that the workmen persist in their efforts for the recognition of their unions and organizations. Now what do we observe in actual existence? Is it the workmen who are demanding premium systems, profit-sharing plans, or bonus systems? On the contrary, all such schemes have been devised by the employers for the purpose of interesting the men in their work and in the attainment of a maximum output, and all of them have been bitterly opposed by the men as tending to differentiate between the abler and the poorer workmen. The workmen—or the unions, as representing the workmen—must be intelligent and fair enough to recognize that any scheme of profit-sharing must, in simple justice and in plain common-sense, apportion the profits distributed in accordance with the degree to which each employee contributed in enabling profits to be made. The careless, time-serving workman is never a profit-maker. The aim of the premium and bonus systems is to select automatically and to reward proportionately the workmen who do make the profits.

It was not the thousands of employees of the United States Steel Corporation who urged that they might be given opportunity of becoming shareholders in the company; on the contrary, the plan for enabling the men to participate in the profits of their work was arranged entirely by the administration, and accepted by the men as individuals, after a most sullen reception by the labor organizations.

Again, it is well understood by the modern successful corporations that reductions in the cost of the finished product are made, not by reductions in the wages of the employees, but by the increase in the output, and that foreman who is most approved by the administration is not the one who hires the cheapest men, but who knows where to get hold of high-priced men of still higher productive ability.

These are facts—facts which may be verified by those who will go, not to the old-time shop, run in the old-time paternal fashion, but to the modern establishments, operated by corporations, without souls, it is true, but with brains; establishments using modern machinery, modern high-speed tool steels, modern intensified methods of production, and, against the determined opposition of the unions, modern systems for determining the wages of the men according to their individual ability, and not by the limitations of the most inefficient members of their organizations.

IT is a little curious to look back two or three years and compare the then prevailing excitement over the United States' "capture of the steel markets of the world," which was very generally supposed to be nearly impending, with the conditions since and still existing. Instead of driving the British and Continental ironmasters out of business, as certain over-excited persons seemed to expect, we have been fairly good customers for their product. Instead of flooding the markets of the world, we have not been able quite to keep pace with the enormous expansion of our own wants.

But with any let-up in the home demand export business will leap again into prominence, and it is noteworthy that Britain, at least, has never forgotten her alarm at the prospect of the American invasion, nor ceased to study her lines of defense. For this reason it is interesting to review a recent synopsis of the British iron-ore supplies.

* * *

LESS than a quarter of a century ago, when it was possible to make profitable use of ores which would not now pay for the cost of smelting, the output of British ore in a single year exceeded 18,000,000 tons. Since then, however, the annual production has varied between 11,000,000 and 14,500,000 tons, which has, of course, had to be supplemented by considerable imports from other countries. Not only have districts such as South Wales, South Staffordshire, and Shropshire ceased to make substantial contributions to the sum of British raw materials, but the time seems not far distant when the same will be said of Scotland and even Lancashire and West Cumberland—the centre of the most valuable ores now raised in the British Isles.

In support of this view it has been pointed out that, since 1886, Scotland has reduced its annual output of iron ore from 1,500,000 tons to little more than 800,000 tons, while the figures having relation to Lancashire and West Cumberland are respectively 2,680,000 and 1,730,000 tons. Outside the deposits at present being worked, there is no doubt an abundance of ore left in many parts of England, notably in Devonshire and Cornwall and Northumberland and Durham, but it is questionable if, under existing conditions, any very considerable proportion of it could be utilized with profit. The ore fields of the Cleveland district are enormously rich in unexhausted supplies, but the ore, it is notorious, is of low grade and would scarcely pay for the cost of reduction. In West Cumberland, where, it is believed, there are still untouched large deposits of excellent ore, the difficulty appears to be that the veins need to be located by costly borings. There is no famine at the moment, nor is one probable in the future; all that seems likely is that Britain must more and more depend upon foreign and colonial supplies. Of these there is never likely to be a dearth, for as soon as one source of supply is closed, another will surely be opened. It is probable that for some years to come, England will continue to rely largely upon Spain, whence she now receives nearly 80 per cent. of her total imports of iron ore, and upon Sweden, Norway, and Greece. In British colonies a beginning has already been made. For several years past India has contributed considerable quantities of manganese ores. Newfoundland last year exported more than 100,000 tons of iron ore, and Australasian and South African supplies are looked forward to as possibilities of the future. But it would not seem wise for British ironmasters to place much hope upon these distant sources of supply, for in this connection freights and the future selling price of pig iron are considerations which must not be ignored.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

RAILWAY TRANSPORT IN ENGLAND AND AMERICA.

A COMPARISON OF BRITISH AND AMERICAN PRACTICE SHOWING LOCAL ADAPTATIONS TO LOCAL REQUIREMENTS.

Report of Colonel Yorke.

INTERCHANGE of ideas upon practical subjects has always been considered an important element in technical training, and it is a question whether the more modern systems have provided anything which really takes the place of the *wanderjahr*, or student journey of the German apprentice. The same idea, however, is being developed on a far larger scale at the present time in the excursions which are being made by engineering societies, by technical and industrial deputations, and by government commissioners. Such journeys of inspection cannot fail to prove beneficial both for the visitors and for the countries in which they travel, especially when the results are embodied in papers and published reports for all who choose to read.

Among important papers of this sort may be noted the report of Lieut. Colonel H. A. Yorke, R. E., to the President of the Board of Trade upon his visit of inspection of American railways, and some portions especially will be found interesting reading on both sides of the Atlantic.

One of the difficulties in preparing reports of this kind is that of conveying to the mind of the reader many things which have combined to make up the impressions upon the writer, but which cannot be described in detail. A comparison of the American method of securing the rails, using only hook headed spikes, without cast iron chairs, but with a much greater number of sleepers, and the British system of chairs and keys, and fewer sleepers, can hardly be made intelligently unless the difference in local conditions is understood. In the early history of American railways wood was plenty, and even now is much less costly than in Great Britain, while the necessity for pushing railway construction rapidly through a rough country rendered the simpler method of spiking desirable. So far as the completed way is concerned, each appears to be well adapted for its environment, and while the higher class railways of the eastern and middle states are constructed on the same general plan as the earlier roads, the liberal use of sleepers, and the excellent ballasting renders them the practical equivalent of the more complicated British system.

The whole development of American railways must be regarded from this viewpoint, and this will go far to clear up many points about which extended arguments have been held. In the United States large loads are to be hauled long distances, this rendering long trains, large cars, and heavy locomotives essential. Fortunately sufficient space was allowed for growth in the early work, the space between tracks being 7 feet in America as against 6 feet in England, while the head room under bridges and in tunnels permits a height of 16 feet 6 in. as compared with but 13 feet in England. These limitations have necessarily governed the dimensions of all structures used in connection with railway operations. Not only is this true of arrangements for height and width, since there are serious difficulties in the way of introducing wagons of great length for general service in England.

"The sidings, goods sheds, weighbridges, turntables, coal tips, screens, etc., are as a rule quite unsuitable for wagons of the dimensions named (to say nothing of the usual conditions of trade, which are based on the present style of vehicle. It is sometimes suggested that English companies should forthwith reconstruct the whole of these works and appliances, but no one has yet estimated what the cost of such alterations would amount to. It is probably incalculable, and the question arises whether, after all this vast expenditure had been incurred and the whole trade of the country had been disorganised during the transition period, the saving in handling the traffic would pay the interest on the outlay. The four-wheeled wagon will therefore in all probability remain the standard wagon of the country, and economy is to be sought in improving the design of such wagons and increasing their carrying capacity in relation to their tare, rather than in introducing wagons of greater length."

Under the conditions of traffic it is doubtful if there would be much if any advantage in using greater wagons in England. The present wagons are not generally loaded to their full capacity, and it is only for hauls of greater length than those usually occurring in Great Britain that the large car is of advantage. Coloner Yorke's report, in this respect, as in many others, but confirms the view that each system has grown up in accordance with the demands upon it, and that any wholesale change would be inadvisable on either side.

In regard to electric traction, the most important feature which Colonel Yorke found to report was the development of interurban electric railways. The relation between these and the steam railways, while at present antagonistic, will probably become settled as each finds that there is business enough for both.

"Such lines are becoming of increasing importance, population becomes more numerous in their vicinity, land values are enhanced, industrial enterprise is stimulated, and the convenience of the public is served by a frequent and cheap means of transportation, not only for passengers but also for freight. Farmers are said to appreciate the facilities thus afforded them for conveying their produce into the cities, and large quantities of milk are now daily carried into the markets by electric cars. Where steam railroads exist side by side with the electric lines, the competition between the two has been keen. Steam roads, having seen a large share of their passenger business taken from them, have made a hard fight to retain the local freight business. But it would appear that the increased prosperity and activity in a district which are promoted by the presence of an electric line result in bringing more business to the steam lines. So that while the electric lines will probably carry the local traffic—passenger and freight—for short distances, they will act as feeders for the through business of the steam roads. In other words, there is a place for each, and their interests are best served by working in harmony."

The extent to which such interurban railways could be developed in Great Britain remains to be seen. It will not do to regard them merely as extensions of street tramways; they are rather a variety of main-line road.

"Experience has proved that a substantial, well-laid track is a vital factor in the economical operation of such a road, and a large factor in its earning capacity. The question of the best type of car for such railways is still receiving much attention in the States, and has not yet been finally decided; but it is found that a heavy, substantial vehicle is necessary, and that the wheels should have deep flanges, broad treads, and strong axles."

The comparison between the American interurban railways and such examples as have already been constructed in England is strongly brought out by Colonel Yorke.

"In England the electrical interurban railways, which have been constructed under the Light Railways Act of 1896, differ in every respect from similar lines in America. They are almost invariably laid alongside the high roads, have light rails and insufficient ballast, while the cars employed on them are mostly double-decked, and have tramway wheels with small flanges. Such lines are nothing more than tramways, and quite unsuitable for high speeds. If railways of this nature are to be as successful here as they are in America, their owners must, I venture to think, profit by American experience, and follow American methods."

That such a complete and unbiased account of transport methods in America will help largely to clear up the situation in Great Britain, must be admitted. On the one hand it will go far to show that British railways are probably quite as well adapted to the traffic conditions under which they are operated as the American roads are to their surroundings. Each is the outgrowth of its environment, and only in minor details can methods be transplanted to advantage.

So far as electric traction is concerned, conditions are different. In the United States the greater rapidity with which electric traction has been developed has enabled valuable experience to be gained which British engineers would be foolish to throw aside. Mistakes have been made in many directions, but it is by those very mistakes that England may profit, if she will, to her material advantage, both socially and financially.

FLAME ARC LAMPS.

EFFECTS OBTAINED BY THE EMPLOYMENT OF CARBON TERMINALS IMPREGNATED WITH METALLIC SALTS.

J. Zeidler—Berlin Electrical Society.

VARIOUS efforts have been made of late to improve the effect and efficiency of the arc lamp, possibly because of the progress in the allied field of incandescent lighting, and in some instances there appears a similarity in the methods adopted. Originally the electric arc depended almost entirely upon the incandescence of the carbon terminals for the production of light. The carbon is vaporised, it is true, but it emits but little light, and because of its low conductivity it does not materially assist in the passage of the current. It is altogether natural, therefore, that efforts to improve the arc lamp should be directed toward the introduction of vapors of other substances. Already the Bremer arc lamp has been brought into notice, the principle upon which it is constructed being the impregnation of the carbons with salts of barium or calcium, these producing vapors of barium and calcium in the arc, adding by their incandescence to the illuminating power, and permitting, by their conductivity, the use of a much longer arc than is otherwise possible; hence the name "flame" arc lamps.

In a paper recently presented before the *Elektrotechnische Verein* of Berlin, and published in the *Elektrotechnische Zeitschrift*, Herr J. Zeidler discussed latter form for use with impregnated carbons, as made by the Allgemeine Elektrizitäts Gesellschaft, with numerous illustrations of lamp construction and action.

These lamps are intended for use with impregnated carbons, this being the essential element in the production of the flame arc, but the carbons used with them are claimed to produce no residue or slag upon the points of the electrodes to increase the resistance, the impregnating material being wholly vaporised and thus enabling a quiet, steady light to be maintained. The nature of the impregnating salts is not revealed in the paper, but doubtless they belong to the group of alkaline earth, metals, such as barium, strontium, or calcium.

Two forms of lamp are described by Herr Zeidler, one being similar to the ordinary arc lamp, the carbons being placed vertically above one another. The principal modification necessary with this form is that due to the increased length of the arc, since it is necessary to arrange for the movable carbon to be drawn back further after the current is started than is done with the ordinary carbons. In practice it is found that the steadiness of the light is improved by the use of thin carbons, presenting a small surface at the points. For this reason, and also because of the presence of the impregnating salts, the carbons are consumed more rapidly than are those of the ordinary form. This is partially provided for by making them as long as practicable, besides which double-carbon lamps, similar to those originally introduced by Brush in the United States, are employed, one pair of carbons being thrown into action only after the other is consumed.

The other form of lamp is called by Herr Zeidler an "intensive" flame arc lamp, and is constructed with the two carbons arranged

side by side, forming an acute angle with each other. A forward movement of both carbons thus brings them together, while they are separated when retracted. This arrangement permits both carbons to be placed above, the arc being formed below, no shadow of the carbons being thrown down. The lamp may thus be suspended, with the enclosing globe below, being especially well arranged for the useful distribution of the light. With this arrangement it is also practicable to maintain the arc in the focus of a concave reflector, so that a large portion of the light is effectively utilized..

Both forms of these lamps are arranged for use with continuous or alternating currents, the feed mechanism being of the differential mechanical type with shunt windings, the parts being duplicated for the double-carbon lamps. The general mechanical details of the lamps appear to be well worked out, and if fuller information were given as to the material and method of impregnating the carbons the account would be very complete.

Some interesting experiments are related as to the effect of a magnetic field upon the arc, this acting to spread the arc and make it larger. Photometric measurements show, however, that no increase in illumination is produced thereby, and hence no useful purpose is served.

The economy obtained by the use of impregnated carbons is well shown in the photometric tests made with the new lamps as compared with those using the ordinary carbons. These tests are tabulated in the original paper in detail. In general it is sufficient to state that for 220 volts and 9 amperes the hemispherical intensity with the flame arc lamp was from two to three times that of the ordinary arc, while the intensive flame arc lamp gave fully four times the hemispherical intensity, using alternating current.

The colour of the light may be controlled to a certain extent by the preparation of the carbons, these being provided to give either a yellow or a milk-white light, according to the character of the impregnating material. Those for a white light, however, are not so steady as the yellow ones. The latter are best suited for indoor illumination, the former for show windows and similar public uses. Neither lamp, however, is adapted for photographic purposes, the greater actinic power of the violet rays of the ordinary arc lamp being preferable.

While the paper of Herr Zeidler is interesting as showing the efforts which are being made to develop the efficiency of the arc lamp and enable it to maintain its superiority for certain purposes over the improved forms of incandescent lamps, it is disappointing for what it does not say, and is incomplete in that it withholds any account of the materials and methods used in the preparation of the carbons. Secrecy in matters of this sort is rapidly disappearing from the work of the more progressive manufacturing establishments, dependence being placed upon legal protection for the guarding of proprietary rights, while methods are disclosed with true scientific frankness. In any case the activity of interested investigators may be depended upon to develope identical or similar processes, so that the publicity can only be delayed.

PROBLEMS IN ELECTRIC DRIVING.

SPEED REGULATION AND MOTOR CONTROL IN CONNECTION WITH CONTINUOUS AND ALTERNATING-CURRENT INSTALLATIONS.

Engineers' Club of St. Louis.

ELECTRIC driving, as applied to machine-shop tools, appears to have outgrown the point where the advisibility of using it is concerned, and the present question for discussion is not "Shall we introduce electric lighting?", but rather "How shall we introduce electric driving?" An interesting discussion before the Engineers' Club of St. Louis, published in the *Journal of the Association of Engineering Societies* brings out some practical ideas on this point from several members, and some abstract of the discussion is here given.

In the first place, the original question as to the relative economy of electrical and mechanical transmission of power appears to be a secondary matter. When electric driving was first introduced this was the main

argument, but of late the greater advantage of providing each machine with its own motive power appears in the ability to operate the individual electrically-driven tool at its maximum output. Shop managers are not slow to perceive that by means of electric driving the output of individual tools may be easily doubled and sometimes trebled over that possible when all the machines receive their power from the same source. This feature is of especial importance in connection with the various plans for the increase of individual output, now being generally considered in many shops. With the advantages of the new high-speed tool steels and the incentive of premium and bonus systems of payment it is almost essential that each machine shall be capable of being driven to its maximum capacity, and since that maximum varies according to the work and the material, the necessity for an independent control of ample motive power appears. It is not a question of providing something equal to the old form of motive power, but rather the provision of a source of power capable of keeping pace with the progress of the other elements of intensified production.

Electric driving may be obtained from either continuous or alternating currents, and the best methods of applying these formed an essential portion of the discussion under consideration. For all constant service the alternating-current motor stands on an equal footing with the direct-current motor; and in view of its greater flexibility and inexpensive maintenance the alternating-current motor possesses certain advantages. At the same time no entirely satisfactory system has yet been devised by which speed variation comparable to that possible with the direct-current motor can be secured. It is possible that this defect may be supplied by the addition of an auxiliary mechanical speed controller, but thus far no entirely acceptable device of this sort has been produced.

Direct-current motors may be regulated as to speed in three different ways: by rheostatic control, by multi-voltage control, or by some special method, adapted for the special tool to be driven.

In the rheostatic control system the motor is of the well-known shunt type, supplied from a constant potential system of distribution. Speed variation above the normal speed of the motor is secured by the introduction of resistance into the motor shunt field circuit; speed variation below the normal is obtained by the introduction of resistance into the armature circuit. When armature resistance is used for speed reduction, however, the efficiency of the motor is lowered, while the speed will vary for varying loads. This difficulty is partially met by the use of variable field resistance.

The method of speed variation by multiple voltages has been employed by various makers in various ways; the difference in voltage of the circuits providing for wide variations in speed, supplemented by the use of shunt resistance for the intermediate speeds.

Special motors are constructed by some makers, being provided with two independent armature windings which may be combined so as to produce the special speed changes desired; while in some instances storage batteries have been used.

There seems to be a general opinion, however, among the advocates of electric driving that a greater range of speed variation is required than can advantageously be secured in the motor itself. Nearly all machining operations are included under the two varieties of finishing cylindrical and plane surfaces. For the latter the speed variations are necessary only to provide for the differences in material to be worked, and these are entirely within the range of motor variation. Cylindrical work, however, requires changes in speed both for the material and for its diameter, since the same rotative speed gives lineal speeds varying with the size of the work. To provide for such a great number of speed changes thus required for lathes, boring mills, and similar machines is more than can properly be demanded of the motor alone, but it may readily be accomplished by a combination of mechanical and electrical means.

An important element in the selection of motors and methods for driving machine tools is the nature of the maximum load. In most machines of a reciprocating nature, such as slotters, planers, shapers, and the like, the power is largely consumed in the reversals of the machine, varying with the speed, and affected in a minor degree only by the actual work being done. In cases of

this kind the motors should be specified to run on full field, full voltage at the maximum speed required, the speed variation being obtained by use of multi-voltage circuits and shunt field resistance for intermediate speeds, no resistance being used in the shunt field of the motor when the motor is operating on full voltage.

There is every probability that ultimately the alternating system will be generally used for machine shop driving, and the experience of the firm of Ganz & Co., of Budapest, is cited as an example of successful work in this direction. Here standard two-phase or three-phase motors are used, wires from two generators furnishing fifty and twenty-five cycles respectively, are taken to each motor. On the higher frequency the motor runs without transformer; on the low frequency a transformer is inserted, reducing the voltage to a point where the best efficiency is obtained in the motor. At the Oerlikon Works, in Switzerland but one set of wires from one generator is taken to the motors. The motors are made with short-circuited armatures and two sets of field winding, one with double the number of poles of the other. A combination of these two systems it was suggested, might give all the advantages of the best multiple voltage control system, dependent, of course, upon cost and electrical efficiency.

This whole subject of electric driving is broadening out in a way which could scarcely have been foreseen. Realizing that by far the greatest element of the cost of the product lies in the wage of the workman, and in full view of the fact that wages have a continual tendency to increase, the works manager has seized upon the possibilities of independent driving to aid him in sorting out the men and methods of greatest productive capacity, and in lowering costs by increasing output per man and per machine. Viewed in this light, all comparisons as to the cost of transmitting power by mechanical and electrical methods become unimportant, and thus the whole subject is cleared up in a manner which cannot fail to aid in its intelligent consideration.

PREMIUM WAGE-SYSTEMS.

DETAILS OF THE PRACTICAL OPERATION OF THE ROWAN MODIFICATION OF THE PREMIUM SYSTEM IN A MARINE ENGINEERING WORKS.

Institution of Mechanical Engineers.

IT appears now to be fairly well settled that some sort of an arrangement whereby the wages of a mechanic should be proportioned to the performance and the output, as well as the time, is a practicable way of settling a most important element in the labour problem. For this reason the paper of Mr. James Rowan, recently presented before the Institution of Mechanical Engineers, dealing with the success which he has met in introducing a modified form of the premium system in his own works, forms most interesting reading, and it should lead to a trial of the experiment in numerous other establishments.

Broadly, the premium system, as described by the originator, Mr. F. A. Halsey, in his paper before the American Society of Mechanical Engineers in 1891, consists in setting a time for each job of work, within which time limit the workman is supposed to be capable of completing it without difficulty. For all the time inside this allotted limit saved by the workman a premium is paid to him, this being an inducement to him to complete the work in less time than the original allotment. If, however, the time limited is exceeded the workman still receives the regular time rate of wages to which he has been accustomed. According to Mr. Halsey's plan, the workman's premium is a time allowance of one-half the time saved by him over the original number of hours fixed for the job. According to another system, also used in the United States, a determinate bonus is paid to the workman for completing the job in less time than was allotted to him, while according to the system described and used by Mr. Rowan, the premium is made proportional to the ratio between the time saved and the man's wages. In any case, the fundamental idea is the same, namely, to interest the workman in the rapid completion of the work by enabling him to share in the gain thus effected. It will be seen that a most important element

in the success of any such system lies in the fixing of the time limits upon the various jobs, and Mr. Rowan's practical experience in this matter renders his paper especially interesting. Says he:

"Before deciding to introduce the premium system the following points should be well considered, namely, the amount of personal work involved, the prospective expenditure of capital, the perseverance required on the part of the management to maintain it, and the initial outlay on the rate-fixing department. It is only by the most assiduous attention and the utmost perseverance that it will be successfully carried through. It should never be allowed to be a failure. It would be better not to attempt it, if there is any chance of failure, and it certainly should not be introduced into any workshop hurriedly or before arrangements are thoroughly made.

"The first thing to be done by a firm introducing a premium system is to establish a rate-fixing department. It is of importance that a separate department be started, and that the rate-fixing be not placed as an additional duty upon the foreman. No one need be alarmed at this, as two men will do all the rate-fixing that is required in an engineering workshop employing about 300 men. In a very short time the rate-fixing, time keeping and wages-costing departments will merge into one, as the work done is so much allied. Two men, with the assistance of two timekeepers and two boys, will do all the work that is required, until the wages are abstracted and invoiced against the different jobs. The man in charge of the rate-fixing department should be a trained engineer with a good deal of workshop experience and some experience in the drawing office. An intelligent man, with this training, soon gains the confidence of the workmen, and in a short time is able to fix time allowances with wonderful accuracy, and his practical experience is of great assistance.

"It is essential to have data as to the times taken by the men at the various jobs when working on time wages, before the premium system can be introduced into any workshop, and the following hints may be useful. Let it be assumed that the workshop has been working on time, and that the times to do the various operations have been taken in detail by the timekeepers or recorded in some manner by the men themselves, as is done in many workshops, or where the work is large, such as marine engines, electric-light engines, etc., that the times to do all the operations have been recorded against the contract as a whole. It may be considered by some employers that the times as thus taken by their timekeepers, or recorded by the men, afford them sufficient information to start upon. Too much value, however, should not be attached to these times, and they should not be used as a basis for fixing time allowances."

The data gathered previous to the introduction of the premium system should relate not only to the standard work of the establishment under consideration, but also to the various elements of the operations, since the possession of this information enables new combinations to be made in determining the rates for fresh operations. This information may then be arranged for subsequent use, so many holes of a given size per hour being allowed, or so many minutes per inch diameter of flange. In the United States it is not uncommon for certain operations to be reduced to mathematical formulas, by which new combinations may be readily calculated, and this side of the question, among others, will be found discussed in the paper by Mr. Colwell, elsewhere in this issue. Special slide rules are sometimes used for such computations, but in all cases much must depend upon the judgment of the rate fixer.

It has been Mr. Rowan's experience that in most cases the time taken to do any piece of work can be reduced, although it may require capital expenditure, together with the assistance of education and intelligence. This is, of course, common knowledge, but it may be questioned if the best use is made of this knowledge, except in workshops where a number of machines are employed in doing identically the same class of work. No doubt, in these workshops great attention is concentrated on the machines, with the result that their output is good, but where the machines are employed doing a variety of work, as in the manufacture of large engines, it is very hard to tell whether the time taken to do the work is good or bad. If, however, the time taken to do the work is down in black and white, and repeated again and again, the management should ultimately have no difficulty in deciding

whether the work is done in good time or not. In estimating time allowances, after the system has been working for a period, there is nothing so useful as a comparison of the times allowed for similar jobs, and there is no question as to the value of this comparison, more especially in jobs which require considerable setting and some degree of skill and intelligence on the part of the workmen, and where the time the machine is cutting is only a minor part of the time actually required for the job. Data accumulate very quickly, and soon, no matter what job comes along, the rate-fixer can estimate a suitable time allowance for it which will be fair both to employer and workmen.

In the process of establishing time allowances, errors may be made, and it may be found necessary to either shorten or lengthen the times first tried, and every precaution should be taken to avoid the necessity for such changes by fixing time allowances as carefully as possible. It is also essential for success that anyone adopting the premium system should deal in all fairness when fixing time allowances.

Mr. Rowan shows that the introduction of the premium system into his establishment has resulted in the reduction of the times of all the machinemen during four years by 20, 23, 31, and 37 per cent., with a proportional increase in the men's earnings. The men are thoroughly satisfied with the system, and have no desire to return to the time method, and apparently all is satisfactory on both sides.

The most important element to the employer apart from the increased capacity given to the shop lies in the proportional reduction in establishment charges, these remaining a constant total to be divided up over a greatly increased output. This is a gain which cannot be too highly estimated, since the general expense account has always been one of the difficult problems in successful works management. The increased interest among the workmen also stimulated is most valuable, all alike looking to the use of tools, materials, and methods which will facilitate their work and enable them to earn larger premiums.

Many men have argued against the practicability of such systems, and such objections have come from both employers and workingmen, but the records of Mr. Rowan and many others who have had success with the premium system form the best reply which can be made to such objections.

THE UTILISATION OF TIDAL ENERGY.

A DICUSSION OF THE PRACTICAL DIFFICULTIES IN THE WAY OF THE APPLICATION OF THE ENERGY OF OCEAN TIDES.

Canadian Society of Civil Engineers.

AMONG the various sources of natural energy the ocean tides have often been considered as a practicable possibility, although up to the present time, with the exception of a few small tide mills, no actual installation of machinery, for the purpose has been made.

It is a question, however, whether the practical obstacles to be encountered may not make such power cost nearly as much as it is worth, and this phase of the subject is examined in a paper presented before the Canadian Society of Civil Engineers by Mr. C. P. Baillairge.

The most apparent difficulty in connection with the utilisation of the power of the tides appears in the irregularity of the movement. Not only does the tide rise and fall twice every twenty-four hours, but the range of rise and fall is continually varying, so that there is not only the lull at high and low water, but also the difference between spring and neap tides to be considered, all of these rendering the direct utilisation of tidal energy impracticable for any except a very limited number of industries. The most obvious method, therefore, of utilising the tides involves some such regulating method as the retention of the high water in some kind of a reservoir, the flow from this reservoir being used between tides to operate turbines or similar water motors. Such tidal reservoirs are seen in the docks at Liverpool and elsewhere, and their construction is entirely practicable, although some regulating mechanism would be necessary, such as the throwing into action of an increasing num-

ber of turbines as the head of water diminished in order to mantain a fair degree of unformity in the amount of power developed, but such details appear to be feasible.

Another method, and one which has been suggested with numerous modifications, is that of a float or pontoon, rising and falling with the tide, connected with some fixed point by means of a beam or similar device, through which the power may be transmitted for conversion into rotary or other form of motion.

Both of these devices, however, are subject to another practical objection, namely, the slowness of the tidal movement. Thus, if we take a location in which there are tides averaging twelve feet, we have twenty-four feet of movement per tide, or per twelve hours, the equivalent of two feet per hour, and although this vertical movement extends over the whole body of water, it must be converted into some more rapid motion before it can be made available for operative power purposes. Mr. Baillairge examines the multiplication of the speed by means of gearing, and shows that even with a very moderate allowance for frictional losses fully 75 per cent. of the power would be absorbed in speed multiplication. Of course it might be practicable to impound a large reservoir of water at high tide and hold it back until the period shortly before and after extreme low tide, and discharge it all in that brief period through turbines at a practicable rate of speed, but the energy would then be available for but two short periods every day, and its uses materially limited, except for charging electrical storage batteries or similar work.

All the plans which have been advanced for the utilisation of the energy of the tides appear to have assumed that a vast amount of power is readily available, if only suitable machinery can be devised to harness it. It is therefore interesting to examine the computations of Mr. Baillairge as to the actual amount of power to be had from any given example. Apparently it is an almost irresistible power, since with the tide everything rises upon its surface even to a twenty to thirty thousand ton ship, and in a similar manner it would lift a whole city if built on a water-tight bottom or pontoon with depth of water sufficient to allow it to sink until the weight of water displaced were equal, as with a vessel, to the weight supported.

Such ideas, however, are deceptive, since the real work performed by the tide is measured, not by the weight of anything floating upon it, but by the actual weight of the water and the distance through which it is lifted. Thus, if we take a square foot of surface, and a tide of twelve feet, we have for the work performed by its rise and fall the weight of twelve cubic feet of water raised to an average height of six feet, or about 4,500 foot-pounds in six hours; this corresponding to 12½ foot-pounds per minute for a square foot of water area with a tide of twelve feet, or approximately, about one foot-pound per minute per square foot of surface for every foot height of tide. Since one horse power is equal to 33,000 foot-pounds per minute it would take 33,000 square feet to give a horse power with a one-foot tide, or with a twelve-foot tide 2,750 square feet per horse power.

In order to obtain a concrete example of what this really means, the Liverpool landing stage may be considered, this being 2,063 feet long, by 80 feet wide, and therefore 165,040 square feet area. With a 25 foot tide, such as is found at Liverpool, this gives 4,126,000 foot-pounds per minute, or 125 horse power.

We see, therefore, that any apparatus to utilise the power of the tides by means of floating pontoons involves very bulky apparatus, and it is a question if the interest on first cost and the expense of maintenance and repairs would not form a very formidable charge upon the cost of the power. Similar computations may be made for the area required for impounding the water in reservoirs, and although less mechanism might be required, the value of land by a tidal river, or the cost of dams and reservoir walls necessarily involves large fixed charges to be borne by the power developed.

While there is therefore undoubtedly a vast amount of power existing in the movement of the tides, it lacks in what may be called concentration, and except in certain favored localities, where the configuration of the land provides natural basins which

may readily be arranged to impound large areas of water, the cost of harnessing and regulating this power must be excessive. The popular idea estimates the power of the tide by observing but a single element, the weight of water elevated, failing to realise that the other elements of which power is composed, namely, time and distance, are so disproportionate as to render the actual power developed much less than really appears. The weight of water elevated has to be multiplied by the distance, which is small, and divided by the time, which is large, and it is only by taking the latter elements into account that a true grasp of the problem is to be attained.

THE RESISTANCE OF THE AIR.

THE EXPERIMENTS OF CANOVETTI UPON THE RESISTANCE OF THE ATMOSPHERE TO BODIES OF VARIOUS SHAPES IN MOTION.

Report of the Société d'Encouragement.

WE have referred already in these pages to the interesting and valuable experiments which have been made upon the resistance of the air by M. le Dantec, and also by M. Canovetti, and now we have the very complete report by M. Barbet, representing the Comité des Arts Mécaniques of the Société d'Encouragement pour l'Industrie Nationale upon the later work of M. Canovetti, published in the *Bulletin* of the society.

These experiments, which were made at Brescia, have already been discussed by the society and in accordance with the report previously presented, M. Canovetti has been awarded a gold medal for his researches. As a consequence of the importance of the work accomplished by M. Canovetti, the Société d'Encouragement appropriated the sum of 1,000 francs to aid in the continuance of the experiments, and a like sum was furnished by the Smithsonian Institution at Washington through the Secretary, Professor Langley.

The present report includes these subsequent investigations extending the scope of the previous work.

It is generally conceded by experimenters that the resistance opposed by the air to moving bodies is proportional to the area opposed by the wind and also to the square of the speed of motion, and the present object of inquiry is to determine the co-efficient expressing this proportionality.

The general construction of the apparatus with which the investigations were made will be readily understood. A copper wire, 380 metres in length was stretched from a point on the fortifications of Brescia to another point about 70 metres below, thus forming a long inclined catenary. Upon this wire a light carriage, made of aluminum tubing, was arranged to travel upon grooved wheels, these wheels being fitted with ball bearings, and every precaution being taken to reduce the frictional and other resistances of the carriage to a minimum. The body of which the resistance was to be tested was suspended to the carriage, the connections being of wire, so arranged as to maintain rigidity, and at the same time add an inappreciable amount to the weight and resistance.

It is evident that with such an arrangement, if the carriage and its surface offered no resistance, the velocity attained at any moment would be that due to the fall. In fact the observed velocity is always less than would be that of a body falling from the same height. This is partly due to the frictional resistance of the carriage but principally is caused by the resistance offered by the air to the surface attached to the carriage. At the beginning of the fall the speed increases, but since the resistance of the air increases with the speed, the velocity is gradually checked until the two forces balance each other, after which the motion becomes uniform. The resistance of the carriage having been determined by preliminary trials this portion may be deducted, and the remainder represents the resistance opposed by the air to the surface under consideration.

In the later experiments the length of the wire was reduced to 127 metres, while the height was nearly as great as in the earlier case, being 63.2 metres, thus giving a more rapid descent in the upper portion, and the wire was so placed as to be sheltered as

much as possible from the action of the wind, the lower portion running down into a protecting trench for more than one-third of the total length. As a further precaution against the possible disturbing action of the wind M. Canovetti states that by observation of the catenary of the cord attached to the carriage for the purpose of hauling it up it was possible to perceive any lateral deflection due to wind, and under such conditions the experiments were deferred.

The results of the experiments are given in full in the form of tables, the forms of the various surfaces tested being shown by drawings, and the time required to travel a given distance after the velocity had become uniform being given in fifths of a second. From these the value of the co-efficient K in the formula for air resistance is deduced for each experiment, the results forming a mass of data in form most available for subsequent study and application.

While it is impracticable to reproduce the general results of these important experiments in this place, some of the more interesting facts may be mentioned. Thus, a circular disc exposing an area of 0.073 square metre, moving at a velocity of about 12 metres per second was opposed by an air resistance equivalent to 84 grammes, when reduced to the standard of 1 square metre moving 1 metre per second.

The same disc, when fitted with a hemispherical front piece, gave under the same conditions a value of only 21 grammes for the resistance, and when to this was added at the rear a cone of a length equal to five times the diameter of the circle, the co-efficient was reduced to 13 grammes, or only about one-seventh of the original amount. When such a figure is reversed, so that the cone is in advance, the resistance coefficient became equal to 18 grammes, showing that the smallest resistance occurred with the hemispherical portion moving against the air.

While the total resistance increases almost as the square of the speed this is not absolutely correct, the value of the coefficient being found to diminish somewhat with increasing speeds. Thus for a disc of 0.80 square metre surface, moving at a speed of 4 metres per second, the value of the co-efficient was found to be 88 grammes, while for the same disc moving at a speed of 7 metres, the value of the coefficient fell to 71 grammes; this confirming the observations of Professor Langley.

The report contains a number of interesting photographs indicating the manner in which the experiments were made, and the comments of M. Barbet confirm the confidence which may be reposed in the accuracy and value of the work.

HIGH-SPEED STEAM LOCOMOTIVES.

DESIGNS SUBMITTED IN THE COMPETITION OF THE GERMAN SOCIETY OF MECHANICAL ENGINEERS.

Glasers Annalen.

PROBABLY as a consequence of the attempts to attain extraordinary high speeds upon the experimental electric railway between Marienfelde and Zossen, the Verein Deutscher Maschinen Ingenieure instituted in March, 1902, a competition for designs for high-speed steam locomotives, the competing plans to be examined in December of the same year. In a recent issue of *Glasers Annalen* the report of the judges is made public, and in a subsequent issue detailed illustrations are given of some of the engines, and we find some interesting features about the machines for review.

There were in all thirteen designs submitted, and in the opinion of the judges no one of these was deemed worthy of the entire award, hence five of the competing plans were given premiums of 1,000 marks each, and the competition was continued between the recipients of these premiums.

The designs published in *Glasers Annalen* bear a close similarity in general appearance, differing, however, in details of construction. In general, they bear a remarkable resemblance to the so-called Atlantic type, used tor express locomotives in the United States, having a swivel truck under the smoke box, two driving axles forward of the fire box, and a truck below or behind the latter. Large driving wheels are thus made possible without preventing the use of a wide grate,

the fire box extending over the frames, much in the style of the Wootten engines, used for many years in America. The designs show an appreciation of the fact that the possibilities of high speed lie, to a great extent, in the steaming capacity, the boilers being as large as the space limitations will permit, both as regards heating surface and grate area.

The advantages of compounding for high-speed appear to have beyen considered differently by the various designers, one engine being a four-cylinder compound, two are three-cylinder compounds, and the fourth a four-cylinder high-pressure machine, the number of cylinders being multiplied for the purpose of balancing. In view of the fact that the limitations to high speed lie largely in the steaming, it appears that the economical use of the steam in the engine practically corresponds to an increase in boiler capacity, and that compounding must necessarily be included for the maintenance of continuous maximum speeds. Experience in France with the engines on the De Glehn system, and in the United States with the Vauclain compounds seem to confirm this view.

In all the designs submitted the question of air resistance seems to have been considered, at least to the extent of providing conical, or prow-shaped outlines to the forward end of the engine, one design going so far as to enclose the entire locomotive in a sort of casing to provide a smooth exterior surface. While the head air resistance may be somewhat reduced in this manner, yet it is a matter of experience that a slight wind on the quarter, crowding the flanges of the wheels against the side of the rail, is a much greater hurtful resistance, and one which is increased with any increase in the area upon which the wind can act.

In one respect an important innovation is advocated. With the large boilers and wide fireboxes of modern express locomotives it has been found necessary to place the engine driver's cab upon the locomotive, this in many cases separating him entirely from the fireman. In some recent designs this idea has been carried out to its natural conclusion, that of placing the driver's cab in the very front of the engine, thus giving him a clear and uninterrupted view of the road, but at the same time separating him from the fireman by the entire length of the locomotive, and rendering communication difficult or even impossible. In one of the designs submitted in the present competition, however, the whole arrangement is reversed, the cab for both driver and fireman being placed at the firebox end of the locomotive, this being made the forward end of the machine, the engine being intended to run backward, according to the existing custom of speaking. There is not the slightest reason why one end or the other of a locomotive engine should be considered as the forward end, and the designer should certainly be left free to choose either, as he may elect. The small locomotives on the elevated railway in New York city are operated indifferently in either direction, while the double ended engines on the Mallet system are necessarily always with one smoke stack in the rear. In this matter, as in various others, convention has doubtless had much to do with the usual defective arrangement in which the engineer is obliged to peer around the greater portion of his machine to obtain but a partial view of the track before him.

Broadly speaking, the designs submitted in the competition show little or nothing new. Large, powerful locomotives, capable of maintaining speeds of 120 kilometres per hour (about 75 miles an hour) have already been built on the same general lines as those submitted in this competition, and the fact that little new has been brought out shows that the limitations in steam locomotive design may already be closely approached. As a matter of fact there must be natural and physical limits to the possibilities of construction of a traveling power house. Apart from the limitations to the dimensions of the boiler there appears the question of the capacity of human effort in stoking the large grates at the rapid rate of combustion demanded. Already in the United States attempts have been made to use two firemen, simply because the powers of endurance of the strongest stokers are singly unequal to the demand, while mechanical stokers for locomotive engines are being discussed, some forms having already been produced because of the heavy requirements and the impossibility of maintaining a sufficiently high rate of combustion with hand firing. In this respect there is no doubt that liquid fuel af-

fords great advantages, and its use will permit a higher rate of combustion and far greater ease of manipulation.

As a matter of fact, however, the whole question of speed limitation at the present time lies, not in the locomotive engine, but in the permanent way. It is altogether possible to attain speeds of more than 120 kilometres per hour either with steam or electricity as the motive power if the road bed be made equal to the task. This was found to be true in the trials between Marienfelde and Zossen, the motor cars there being obliged to keep below their maximum speeds because of the dangerous vibrations caused by the condition of the track. If extremely high speeds are desired it will be necessary to lay much heavier rails, to provide more solid way, to secure practically perfect alignment, in both horizontal and vertical planes; in short, to remove all external causes of vibration. When, on track of such a character, the maximum speeds of the existing torms of locomotive, both steam and electrical, have been demonstrated it will be time to provide new designs, but not before.

COMPRESSION IN STEAM-ENGINE CYLINDERS.

A COMPARISON OF THE TESTS WITH VARYING COMPRESSION AND THE RESULTS OBTAINED IN PRACTICAL WORKING.

C. L. Browne—Electrical Engineer.

SOME time ago we referred in these columns to the experiments of Professor Dwelshauvers-Dery, at the University of Liége upon the deleterious influence of high compression upon steam economy. These investigations attracted much interest at the time, and were followed by other at various places, it being felt desirable to confirm or refute results contrary to the expressed opinion of such a high authority as Zeuner, as well as opposing the practice of many eminent designers and constructors. In a recent article published in the *Electrical Engineer*, Mr. C. L. Browne collects the results of the experiments of a number of scientific observers upon this question and compares their results with the conditions actually obtaining in practice, giving an interesting view of the whole situation.

The experiments of Professor Dwelshauvers-Dery, made upon the experimental engine at the University of Liége, showed that the steam consumption increased when the compression was raised from 10 to 20 per cent. Further experiments proved that when the compression was increased to 30 per cent. the steam consumption rose 21 per cent., while with a compression of 40 per cent. the quantity of steam required increased more than 50 per cent. over that with no compression. With a condensing engine the losses following upon increased compression were not so great, but the general action was similar.

Experiments made by Doerfel at the Radotin Cement Factory gave corresponding results, the losses following upon increased compression more than counterbalancing the amount of steam saved by the earlier closing of the exhaust port. In these experiments the important observation was made that the condensation losses varied largely with the wetness of the steam used. Some very careful experiments made at the Stevens Institute of Technology, in the United States, by Professor Jacobus showed a slight increase in steam consumption with increased compression, and similar results have been obtained by Professor Carpenter at Cornell University, but in neither of these series of experiments were as large losses found as in the experiments in Belgium and in Germany.

After examining these results, Mr. Browne asks the pertinent question: "How far do these figures represent the results which may be expected to accompany the compression of the cushion steam in modern steam engines? Or, in other words, do the conditions which obtained in the above trials represent those to be met with in everyday practice? The obvious answer is, generally speaking, they do not. Instance the case of the engine used by Dwelshauvers-Dery in his first set of trials. The cylinder was only 12 inches in diameter by 23.9 inch stroke, with a clearance volume of 7.9 per cent., and clearance surface area of six square feet, admission ceasing at one-tenth of the stroke. The temperature range dur-

ing one stroke was apparently about 180 degrees F. Under these conditions it might have been confidently predicted that excessive condensation would take place in the cylinder, since the harmful influence of the cylinder walls would be out of all proportion with the volume of the working steam. The excessive high steam consumption—in one case reaching nearly 56 pounds per indicated horse-power hour—is indicative of the extreme conditions under which the results were arrived at."

In the case of modern steam engines of large power the volume of steam in the cylinder is many times greater than the "wall area" of the engines used in the laboratory tests, and hence the amount of cylinder liquefaction is proportionately reduced. Even in such cases, however, the whole of the work expended in compressing the exhaust steam will not be returned during expansion on the next stroke, since it depends upon other factors, including the difference between the pressures of release and exhaust respectively.

In all cases, however, the action of the cylinder walls is most important, and although not appearing upon the indicator diagram, it has a great influence upon the efficiency of the engine. This will be realised by a consideration of the action going on in the cylinder.

"When the admission valve opens, the steam rushes into the cylinder and strikes against the metallic surfaces of the cylinder and piston. When not originally superheated, the condensation of from 20 to 60 per cent. of the admission steam is the result. As the point of cut-off is reached and expansion commences, more of the chilled wall of the cylinder is uncovered by the piston and a further quantity of steam is liquefied until a point is reached where the fall in pressure causes the layer of water deposited on the metal surfaces to be re-evaporated, and this process continues until the exhause valve opens, and in some cases continues during the period of exhaust. On the exhaust valve again closing, the cushion steam being compressed into the clearance spaces, its temperature at first rises, partly owing to the fact that work is being done upon it, and partly to the heat given by the cylinder walls, the temperature of which is higher than that of the enclosed steam. Immediately, however, that the steam attains a temperature in excess of that of the surfaces which surround it, a layer of water is again formed, and the exaltation of the compression curve on the indicator diagram becomes less rapid in proportion to the decreasing volume of the steam."

Mr. Browne shows that large losses may be expected from high compression when there is a wide temperature range throughout the stroke; when there are large clearance surfaces; when there is early release, and when the steam is wet. All these are wasteful conditions in any event, and should not be permitted if they can be avoided, so that it is hardly proper to condemn compression when tested under conditions of general wasteful operation. When, however, the clearance is small, a moderate degree of compression is found to produce no appreciable loss, and at the same time it may be found advisable in order to insure smooth running.

THE IMPROVEMENT OF CUMBERLAND SOUND.

SUCCESSFUL DEEPENING OF A TIDAL HARBOR ENTRANCE BY MODERN METHODS OF JETTY CONSTRUCTION.

J. H. Bacon—Engineering News.

VERY often the most successful work of the engineer is found to lie in the direction and utilization of forces which, uncontrolled, are producing the very opposite effects to those which are desired. This is especially true in operations of harbor improvement and the production of navigable channels. In some cases recourse to mechanical methods of removing obstructions, such as dredging, must be had, but unless these are used in connection with the control of the action of winds and currents the effect can be but temporary.

An excellent example of the manner in which the action of tides and currents has been utilized to produce and maintain a deep channel is seen in the harbor improvement works at Cumberland Sound, the en-

trance to the port of Fernandina, Florida; and an account of the work which has there been successfully done under the direction of Captain C. E. Gillette is given by Mr. J. H. Bacon in a recent issue of *Engineering News*. This work is interesting also because its location may be considered typical of most harbor entrances on the south Atlantic coast. The characteristics of the site are well described by Mr. Bacon.

"A deep gorge, known as Amelia Basin, extended from the inner sound out between Cumberland and Amelia islands, for a distance of about one-half mile from the latter, and has continued essentially unchanged for many years. At its seaward end occurred the shifting of the channel so common on this coast. The direct course to the northeast across the bar was, at irregular intervals, slowly deflected southward by the encroachment of the sand coming from the north, until its increasing length became too great for maintenance when (usually in some storm) the outflowing tide again forced a new channel straight across the bar, and the same cycle of changes was again resumed."

Under these conditions the available depth on the bar at mean low water was about 12 feet, while the rise and fall of the tide is 5.9 feet. The absence of any material aid from the St. Mary's river rendered it necessary to protect the channel from this sand drift and to utilize the action of the tide to produce the scour to create and maintain a navigable channel, and the works recently constructed appear to have accomplished that end far more successfully than their predecessors.

After referring to the incomplete and disintegrated remains of the inefficient work done on the site prior to 1900, Mr. Bacon proceeds to describe the manner in which the present jetties have been constructed and to show how the results have been attained. The original plans provided for two jetties, the north one extending from Cumberland Island seaward for a length of about 3¾ miles; while the south jetty, about three-quarters of a mile further south, was to extend from Amelia Island outwards, the relative positions of the two islands making the south jetty only about half as long as the north one.

The defects of this plan were seen by some at that time, and in the report of the resident engineer in 1891 it was stated that "should the channel be protected on its northern side by a training wall there will also be gained such concentration of flow along the concave curve as may, and probably will render a southerly training wall superfluous. The adoption of this plan would necessitate the removal of the central portion of the southern jetty, where two courses have been laid." This recommendation if followed, would have resulted in reducing the cost of the works by one-half of the original estimate.

This plan, essentially that of Professor Lewis M. Haupt, was not approved by the Board of Engineers, and accordingly work was continued upon the two jetties, with the result of filling the channel with sand, rendering a breach in the south jetty necessary to permit vessels to enter the port.

When the work was resumed, in 1900, under a new contract, it was begun upon the outer end of the north jetty, and thus a barrier was placed against the prevailing drift of the sand to the bar crossing and at once the currents were aided in restoring their natural channel.

The result to-day has been the formation of a channel close under the lee of the jetty, the depth increasing naturally from 6½ feet to 14 feet, after which it was increased by dredging to 20 feet. The dredging was resorted to only to accelerate the work, and since it was discontinued the channel has still further increased in depth to 21 feet, showing the scour of the tide to be sufficient to maintain the channel without other artificial aid than that afforded by the cover of the jetty. Practically all of this deepening has been produced by the action of the tide against the single north jetty, the reconstructed south jetty having been completed to only about one-quarter of its length from Amelia Island seaward by December 1902, at which time the 21-foot channel had been fully established.

The magnitude of the work which has thus been accomplished will be better appreciated when it is understood that during the period between June, 1900, and June, 1902, 1,056,000 cubic yards of sand were moved from the sections through which the channel passed. "Of this amount 102,000 cubic yards were removed by dredging,

leaving a balance of 954,000 cubic yards that were moved by the scouring action, due mostly to the north jetty."

Mr. Bacon's paper is accompanied by reproductions of several hydrographic charts made at successive dates, showing clearly the action of the north jetty in producing the new channel. Since all of these were made before any appreciable amount of work had been done on the reconstructed south jetty they may be taken as indications of the effect which may be produced by a single jetty placed to windward of the channel to be created.

It is therefore interesting to compare the results which have been obtained at Cumberland Sound with the theory and requirements of the reaction breakwater, as advocated by Professor Haupt, in 1888, and discussed in our review of his recent paper before the American Association for the Advancement of Science in these columns a few months ago. Thus Professor Haupt advocated a single jetty, placed between the channel and the source of prevailing drift, the jetty to be raised above the highest tide, and constructed inwards beginning on the outer slope of the bar, the form gradually curving towards the axis of the ebb current so as to maintain a continuous reaction and consequent scour along its concave face.

An examination of the maps of the work at Cumberland Sound shows that practically all these conditions were closely followed in the location and conduct of this work, with the single exception that the jetty was made angular, instead of being curved. The maps show also, however, that the channel itself took the reversed curved form advocated by Professor Haupt, clearly indicating the path of the scour, and showing the nature of the tidal action. It is not often that such a striking confirmation of theoretical principles appears in a practical instance in which the original intention was guided by altogether different considerations.

The curious thing about the work at Cumberland Sound is that it is thought necessary to complete the south jetty when the work has already been done by the action of the single north jetty. The channel having been made, and the scour continuing to maintain its depth, it seems like an unnecessary expenditure to proceed with a portion of the work so evidently superfluous. At least the lesson which has been learned in this instance may serve as a guide for future works elsewhere, and obviate the necessity for the construction of useless work in other harbor entrances.

HERTZIAN WAVE TELEGRAPHY.

LECTURES BY PROFESSOR FLEMING UPON THE PRESENT STATUS OF THE ART OF TELEGRAPHING THROUGH SPACE BY MAGNETIC WAVES.

Society of Arts.

PROGRESS in the development of space telegraphy is so rapid that one must watch carefully in order to keep up to date with the latest improvements, and for this reason, among many others, the lectures recently delivered by Professor J. A. Fleming before the Society of Arts will be welcomed.

Starting out with the statement that the problem of telegraphing through space lies in the production of electric waves in the ether and in their reception at a distance, Dr. Fleming proceeded to take up the successive stages of the operation, beginning with the aerial radiator, and following with a discussion of the transmitting apparatus and the receiver, concluding with an account of the various methods devised to insure privacy and to guard against interference.

As an interesting analogy to the radiating vertical wire, used by Marconi, Dr. Fleming referred to the action of a siren, emitting acoustic impulses into the lower part of a vertical organ pipe, which thus emits a note, the waves passing off through the air to impinge upon the ear of the listener. In like manner the discharge across a spark gap may be employed to send electrical impulses up into a vertical wire, from which magnetic waves are propagated out through the ether. In order to explain the manner in which the waves are produced it became necessary to enter into some account of the modern theory of electrons, and the state of strain in which their motion places the ether, and this difficult portion of the subject was

made clear to a general audience by some analogies of a mechanical nature.

Retaining the analogy of the vertical radiating wire and the organ pipe, Dr. Fleming proceeded to discuss the various transmitting devices by comparison with the methods which might be employed in setting up sound vibrations in the pipe. Thus the siren involves an air compressor, producing pneumatic pressure, the discharge of which, when rhythmically interrupted, starts sound waves in the organ pipe. In like manner an induction coil or an alternating-current transformer is used in space telegraphy to produce the electrical discharges, this corresponding to the air compressor, while some form of interrupter is employed, just as in the case of the organ pipe the interruptions are effected by the siren.

The various forms of interrupter used in space telegraphy, reviewed by Dr. Fleming, include the older type of hammer break, followed by different kinds of mercury interrupters, and also the electrolytic interrupter of Wehnelt. Mention was also made of the use of the Cooper-Hewitt mercury-vapour tube as an interrupter, but this apparatus has as yet not been practically tested in connection with space telegraphy.

As, in the case of the air compressor and siren, some form of air reservoir is necessary, so in the case of electric wave production a condenser is required. The whole operation of transmission, therefore, includes the production of pressure, storing it up, releasing it in the spark gap, and producing the oscillations in the aeriai radiating wire. The waves thus sent out through the ether require only a suitable receiver, analagous to the human ear in order that the complete transmission may be effected.

Of the first and earliest type of receiver, the coherer, based on the early observation of Varley, Onesti, Branly, and others, Dr. Fleming illustrated several examples, including tapping devices for decohering; and followed with descriptions of the mercury-drop ether, the magnetic detectors of Rutherford and of Marconi, the electrolytic receiver of De Forest, and the thermal receiver of Fessenden.

In this connection we may note the new word, "kumascope," coined by Dr. Fleming, to express broadly a receiver for magnetic waves in space telegraphy, there being such a variety of devices at present under consideration as to render the earlier terms either too narrow or too broad. Whether this particular term will survive or not remains to be seen, but that some equivalent word is desirable will be admitted.

Since it is desirable that the wave messages received should also be recorded, most of these devices are arranged to be used with a recording tape, much in the manner of the Morse telegraphic recorded, but Dr. Fleming maintains that there is no apparatus so sensitive for the detection of electric waves as the telephone and the human ear, although it is possible that a visual receiver may be used to advantage. When it is remembered, however, that by far the greater number of Morse telegraphic messages are already received by sound, there appears to be no very good reason for desiring to improve on that method merely because the transmitting system is a different one.

Probably the feature in magnetic space telegraphy which is now attracting the most attention is that of the possibility of devising practical selective methods, in order that a transmitter and receiver may be so tuned to each other that the receiver shall reject all messages except those intended for it. That some such arrangement is essential to the commercial success of the system appears positive, not because secrecy may not be attained by the use of cipher codes or similar methods, but because, with the multiplication of stations and message the interference must be prevented if a hopeless jumble of waves is to be avoided. The ability to tune transmitters and receivers to each other appears to be proved by some recent experiments made by Dr. Fleming and Mr. Marconi, in which simultaneous communications between Poldhu and the Lizard were maintained, using both the powerful transmitter, employed for transatlantic service, and a much weaker one arranged for communication with channel steamers. No interference took place whatever, and since great precautions were taken to observe secrecy as to the contents of the messages, the absence of any collusion between operators were assured.

As a matter of fact, however, it is not so much the question of secrecy as that of interference, which is to be considered. A powerful transmitting station, it is admitted,

may disturb the service of other stations if the latter are not so tuned as to be irresponsive, and thus there is a real need of some system and agreement among operators and stations, otherwise confusion is certain to result. Intentional disturbances undoubtedly may be produced, since waves of various periods sent out in rapid succession would, to a certain extent, interfere with stations in the vicinity, and, in fact, such methods, it is said, were adopted during the last international cup races in America, and in the course of the recent naval manoeuvres in the Mediterranean.

Dr. Fleming's lectures form by far the most satisfactory popular account of the methods of space telegraphy which has yet been given, and the full publication of the text and illustrations in the *Journal of the Society of Arts* will be welcomed.

SLAG CEMENT IN GERMANY.

THE DEVELOPMENT OF THE MANUFACTURE OF CEMENT FROM BLAST FURNACE SLAG AND ITS COMMERCIAL STATUS IN GERMANY.

G. Jantzen—Stahl und Eisen.

MODERN engineering has become largely a matter of the utilisation of by-products, or rather of products which formerly were considered as wastes, but which at the present time have become in some instances as important as the former main product. Thus the former wastes of the gas works and the coke oven are now found of sufficient value, in some instances, to determine the question of profit and loss, while it is becoming a question whether the gas or the iron is the more valuable product of the blast furnace. The basic steel process includes in its valuable products the phosphate slag, the value of this product as a fertilizer in Germany alone now amounting to 25 million marks yearly.

The use of blast furnace slag in the manufacture of hydraulic cement has been increasing both in Germany and in the United States, and an important paper upon the development of the industry in Germany by Director Jantzen was recently presented before the Society for the Promotion of Technical Industries, and published in *Stahl und Eisen.*

A comparison between the analysis of furnace slag and Portland cement clinker reveals at once such a similarity in composition as to indicate the value of the former for cement making, the principal difference being one of molecular structure. When the fluid slag is allowed to run into water, however, it assumes a granular structure, after which it is finely ground and mixed with about one-fourth its volume of hydraulic lime.

Herr Jantzen reviews the historical developments of the attempts to make a slag cement in Germany, from the early experiments of Lürmann in 1862-5, down to the placing of the product on the market in 1880, since which time it has become an important commercial article. In Germany, as in the United States, there has been considerable controversy about the propriety of applying the name "Portland" to this class of cement. Herr Jantzen reviews the history of the name, showing that it was applied to the cement made by Aspdin in 1824 because of the resemblance of the product to the well-known Portland stone, and takes the position also held by some others that the name applies only to the appearance, and is not essentially connected with the composition or manufacture. At the same time it must be admitted that the name has become so closely connected with a certain class of cements that it is not correct to apply it to slag cements without some qualification to indicate the origin of the product, and indeed, in Germany the slag cements are generally known as "Iron-Portland" cements (Eisen-Portlandzement).

Some idea of the extent to which the manufacture of slag cement has grown in Germany may be obtained from the statement that there are now eleven establishments engaged in its production, and that the yearly output is about 1¾ million barrels of 170 kilogrammes each, the capital invested in the industry being about 15 million marks. A general plan of the cement department of the Buderus Iron

Works at Wetzlar shows very clearly the arrangement of a modern plant of this sort, and gives a clear idea of the extent to which by-product utilisation may develop in connection with the manufacture of iron. Data and results of a number of tests are also given, showing the resistance to tension and compression after various periods of time.

The principal characteristics of slag cement appear to lie in its slow setting and in its freedom from changes of volume. The time required for attaining full resistance is decidedly greater than for Portland cement, but after the expiration of 28 days the slag cement gave a higher resistance than the Portland cement, while the maximum strength was not attained for several months. The question of freedom from changes in volume is important, since a cement which expands in setting may be altogether unsuitable for many kinds of work.

One of the most interesting things referred to in the paper is the use of slag cement and Portland cement mixed, since the best qualities of both products may in great measure be combined. Thus a mixture of equal parts of Portland cement and slag cement sets very nearly as promptly as neat Portland cement, the respective times being 14 and 10 hours. After 28 days the strength of the neat and the mixed cements was practically the same, while after 180 days the combination of slag and Portland cements was 50 per cent. stronger than the neat Portland cement. These results appear to open a wide field for the slag cement, since a reduction in cost may be secured, and at the same time equal if not superior results attained. There is no doubt that slag cement has come to stay, and there is no reason for it to attempt to assume the name or style of existing articles, since it is amply capable of standing on its own merits.

It is interesting to examine the extending scope of the blast furnace in the light of recent developments, since it has now become not only a smelting furnace, but also a fuel-gas producer and a cement kiln, and there is a question as to which of the products may become the most important. The use of furnace gas in improved engines enables the former waste heat to be converted and distributed as electric energy, while the chemical reactions involved in the smelting of the iron and the production of gas are also employed in the formation of the slag, no longer a waste product.

The manufacture of slag cements has now become such an important element in German industry that an influential society, the "Verein Deutscher Eisen-Portlandzement-Werke" has been organised, and the acceptance of this corporate name by the Minister of Public Works establishes the term in Germany, at least, and there appears to be no good reason why it should not be used elsewhere.

FUEL ECONOMY IN STEAM GENERATION.

THE PRINCIPLES OF THE ECONOMICAL USE OF COAL FOR THE PRODUCTION OF POWER BY THE GENERATION OF STEAM.

New England Water-Works Association.

AMONG the valuable papers in the recent issue of the *Journal of the New England Water-Works Association* is one by Professor Ira N. Hollis upon economy in the use of coal for the production of power.

Professor Hollis goes right to the root of the question at the start, when he says:

"The fundamental motive at the base of all human invention is in the direction of saving labor, and thus of increasing the material comforts and leisure of the race. Broadly stated, this means that coal or water must do the work which men formerly did by hand; hence, for every ton of coal which we have been able to save by the increased efficiency of furnaces and machines, many tons have been added to the yearly expenditure by the enormously greater demand for power. We are already beginning to talk about how long the available supply of coal will last, and the late strike in the anthra-

cite regions has quickened interest in the subject, as it has given us a hint of what a coal famine would mean to a nation accustomed to depend upon it for work and heat. Yet we have hardly attacked the problem of economy in the use of coal."

Examining the thermal value of coal and the possible maximum thermal and mechanical efficiency of boilers and engines, Professor Hollis shows that the maximum attainable efficiency, under ideal conditions is 26.5 per cent. Of this we have attained already about 12 per cent., and we are still striving for the remaining 14.5 per cent.

"Engineers may well strive out on a new path. We are struggling with the steam turbine and with other inventions to save a few pounds of coal, while we are wasting tons.

"One of the axioms of modern engineering is that the conditions most favorable to economy are the regular and constant demand for power. Where an engine is to be run at its designed maximum power for twenty-four hours a day, the entire plant can be made to realize a much higher efficiency than would be the case with a fluctuating demand for work. Where this fluctuating demand prevails the plant must be designed for the greatest output and yet used for long periods at much lower rates. This is like employing a man to do the work of a child because at times there are weights to be lifted that require a man's strength. Furthermore, paradoxical as it may seem, there are many cases in which economy would be obtained at too great a cost: a good example of this being found in steam engines for small powers. It would not pay to build a one-horse power with a steam jacket and condenser and air-pump. The first cost would be too great and the skill to render the design effective would be far beyond the ordinary rate of wages. The line of improvement in the use of small powers is clearly pointed out: a central station which can be kept working at a constant rate and some efficient method of distribution to motors of such simplicity that cheap labor can be employed to run them. This may be called the problem of the twentieth century, inasmuch as there are many demands for small power to a comparatively few for power in large quantities."

Examining the present causes for waste in the use of fuel, and their immediate remedies, Professor Hollis says, very truly, that coal is rarely burned in an intelligent manner. Skilful hand firing is more advantageous than mechanical stoking, but skilled hand firing is the exception. While this may be true, and it is possible that much may be done by the proper education of firemen, it must be remembered that firing boilers is by no means a desirable form of work, and men who can learn to do such work well are not likely to remain firemen unless much better paid than is now the rule; while if much higher wages are paid to secure greater skill all the benefit of the firing will be offset by the increased wages.

The dirty condition of most boilers is a fruitful source of loss, and this again is largely due to neglect. Cleaning boilers is even more disagreeable work than firing them, and it will never be effectively done unless under strict supervision and compulsion. The inside may be kept clean by putting only pure water into them, and the best way to keep the outside clean is also the best way to get efficient firing, i. e., to use clean gaseous fuel.

So far as losses in the engine are concerned, Professor Hollis examines principally those due to cylinder condensation. The advantages due to jacketing he shows to depend upon circumstances, and its use should be made with judgment. It is quite possible to over-jacket an engine, heat being lost by using too much jacket steam. The success of a jacket depends largely upon discharging all the condensed water, so that the latent heat stored in the steam may become useful, and hence a good circulation in the jacket is essential. The benefits of superheating are shown to be great, and a moderate degree of superheat is recommended.

Losses from leakage are much greater than are usally suspected, and many calculations upon the action of steam in the cylinder are unreliable because the condition of the valves was not definitely determined and made a part of the record. Another cause of loss by leakage, and one which is not investigated as frequently as it should be, is that of inward leakage of cold air into the flues and boiler brickwork. It is of little use to proportion all parts with care to obtain certain pre-determined re-

sults and then have leaks of unknown magnitude, both inward and outward, producing conditions altogether different from those intended and desired.

When all has been said and done, however, the use of coal for the production of power by means of steam is far from being as economical as it should be, and the paper of Professor Hollis has mainly shown how little we may expect from following existing lines of construction and design. Apparently it is time to strike out on altogether new paths, and it seems as if some guide to those paths might even now be discerned.

It is admitted that the internal-combustion motor is far more economical than the steam engine can ever hope to be. This follows because of its much greater temperature range, and its fewer opportunities for losses. To this fact is added that of the practicability of making lean gas for such engines from fuel which it would be hopeless to attempt to use to advantage in the generation of steam. Apart from this, however, there appears another element in the economical use of fuel, one which has until recently been altogether disregarded. One of the most extensive uses of fuel is found in metallurgical operations, the coke ovens and blast furnaces of the country consuming thousands of tons of fuel in the production of iron, at a rapidly increasing rate. In nearly all such operations the gases discharged after the smelting has been effected are available for the production of power in internal-combustion engines, the coal thus performing double duty, with a corresponding degree of economy.

The principal element in the realization of the utilization of the power available in the waste gases of our coke ovens and blast furnaces lies in the necessity of so arranging the distribution and use of power that it may be available. This is rather a problem in economics than in engineering, since it involves the perfecting of relations between manufacturing and metallurgical industries which at present do not exist. Nevertheless, in these days of combination and consolidation, such arrangements are by no means impossible, and it is altogether possible that the next great move in the utilization of the energy contained in coal will be the development of the iron smelting districts as power-generating centres, from which energy may be distributed at prices otherwise impossible.

INDICATING HIGH-SPEED ENGINES.

PRECAUTIONS TO BE OBSERVED FOR OBTAINING ACCURATE DIAGRAMS FROM ENGINES WITH HIGH ROTATIVE SPEEDS.

Institution of Civil Engineers.

IN recent issues we have reviewed in these columns the methods which have been applied in practice to calibrate the springs of steam engine indicators and to make the necessary corrections for the instrumental errors thus determined. The errors due to the influence of heat upon the springs appear in slow as well as high-speed engine work, but with the latter there are other difficulties which in the early experiences with slow moving engines were almost inappreciable.

In a paper recently presented before a meeting of the students of the Institution of Civil Engineers by Mr. A. Marshall Arter, the elements of error in high-speed indicating were discussed in an interesting and suggestive manner, and some abstract of his paper will here be given.

It is interesting to note that nearly all the improvements which have been made over the original indicator of Watt have been due to efforts to adapt the instrument for use at higher speeds than were at first considered. The substitution of the drum for the flat slide was the principal improvement in the MacNaught instrument, which served all practical purposes until the advent of the Porter-Allen high-speed engine caused Richards to turn his attention to the subject, and to design the form which, with minor modifications has been in use ever since. Even the improvements which subsequent designers have introduced have been mainly with the object of adapting the instrument to still higher speeds, including lighter moving parts, improved drum movements, etc., but with all the attention which has been given to the subject it is yet possible for material errors to creep into the diagram;

and unless the exact conditions under which it was taken are known, erroneous conclusions may be drawn.

In all cases it is important that the friction of the indicator piston be kept as small as possible, but Mr. Arter calls attention to its especial necessity in high-speed work. It is much better to have a piston slightly leaky than to have it too tight, and when the spring is removed from the instrument the piston should always fall freely in the cylinder by its own weight. The choice of spring for high-speed work is also a matter for consideration. Springs are ordinarily rated by their scale and by the maximum pressure they should receive, but the selection should also be governed by the point of cut-off, as influencing the suddenness of the drop in pressure, and by the weight of the moving parts of the indicator and their speed as affected by the number of revolutions of the engine. It is well understood that at high speeds small diagrams are more likely to be correct than larger ones, and some of the manufacturers make special small instruments for high speeds. With the ordinary indicators, however, good results may be obtained by using stiffer springs and taking short diagrams, and Mr. Arter gives formulas for determining the proper height and scale of diagrams for various speeds and pressures for the Darke indicator, used by him in indicating the engines of torpedo-boat destroyers at speeds as high as 400 revolutions per minute.

A most fertile source of error in high-speed diagrams is that of the stretching and sagging of long cords in the drum connection. The tension upon the cord which transmits the reduced motion of the piston to the indicator drum varies with the tension of the drum spring and with the inertia of the drum and of the cord itself. If a constant tension can be maintained upon the cord its length should not vary throughout a stroke. By plotting the combined action of spring tension and drum inertia it can be shown that there is only one particular speed of engine at which the cord tension is constant. Increasing the spring tension does not remove this difficulty, since what is required is a means of varying the rate of increase of tension of the spring, a matter which has, as yet, not been satisfactorily accomplished. Several drum springs may be fitted, for use with various speeds, and Mr. Arter also makes the suggestion that the inertia of the drum may be made variable by supplying drum tops of different weights, the heavier ones to be used for slower speeds and replaced by lighter ones for higher speeds, thus maintaining the inertia of the drum comparatively constant.

Mr. Arter gives a number of diagrams taken at high speeds to show the various errors which may appear, and points out how in many instances the defects have been removed by tracing the cause.

The effect of the inertia of the cord itself is clearly shown by attaching a small weight to the cord and observing the effect upon the diagram, the result being to exaggerate the action due the weight of the cord. The result of the inertia upon the tension of the cord is such as to affect the proportional length of the diagram for the fast and slow periods of its motion, thus causing the cut-off and compression curves to be distorted. Indeed Mr. Arter shows a case in which the inertia effects were sufficient to cause the drum to be stationary when it should be in motion, or even to have its movement momentarily reversed, with corresponding distortions of the diagrams.

An examination of the diagrams illustrating Mr. Arter's paper reminds one of the indicator cards which were exhibited in the early papers about the Richards indicator, showing the defects in diagrams taken with the old McNaught indicator when used at speeds beyond its capabilities. It appears almost as if similar conditions had again been reached in the use of the indicator, and that corresponding improvements were again necessary to meet the high speeds, and pressures, and early cut-offs now employed.

So far as defects from the stretching and sagging of the cord are concerned, they may be minimised by reducing the length of cord employed, replacing the greater portion of the length of connection between the cross head and the indicator drum by a positive member, or one with freedom from stretch. In some modern engines the indicator motion is provided with a steel rod or bar for all but a very short portion of the connection, this being guided and supported so as to make a practically positive connection, but a few inches of string being necessary at the end. Another arrangement has the con-

nection made of tightly stretched piano wire, pulling against a strong spring, a loop near the end of the wire permitting the attachment of the short string leading to the indicator drum. By such means the length of cord capable of stretch and sag may be greatly reduced, and the accuracy of the motion improved.

The great importance of adopting every possible means to insure accurate and reliable indicator diagrams is becoming more generally appreciated as it is understood that the size, speed, and power of engines have increased enormously without any corresponding increase in the scale of the diagram upon which the power is measured. The long end of the lever has been continually growing longer while the measurements still have to be made at the short end. It is not too much to say that no great degree of confidence can be placed in an indicator diagram from a modern high-speed, large-power engine until all the conditions under which it was taken are known, and unless the calibrated errors of the instrument with which it was taken are appended.

INVENTIONS BY EMPLOYEES.

CONTRACT AGREEMENTS BETWEEN EMPLOYERS AND EMPLOYEES AS TO THE OWNERSHIP OF MECHANICAL INVENTIONS.

American Machinist.

IT has long been recognized that the question of the rights of employers to inventions made by their employees is a delicate one, and various opinions have been held concerning it. Formerly the employer insisted that all inventions made by an employee belonged to him absolutely, and when it was found that the courts did not sustain this position it was made the subject of a contract to be entered upon as a condition of employment. At the present time, however, a more reasonable view obtains, and in a recent issue of the *American Machinist* is given a form of agreement between the employees of a manufacturing establishment and the firm, which that journal comments upon editorially in rather favorable terms.

The whole subject is an interesting one, especially as it leads to a consideration of the modern status of the inventor in several directions, as well as to the conditions which best stimulate the development of inventive genius. The contract given in the *American Machinist* after reciting the fact that the employee, by reason of his employment and the nature of the work he is to do, will come into possession of certain knowledge concerning the business which it is not desirable that competitors should possess, binds him not to divulge such information to anyone.

The rest of the agreement relates to inventions and to title in patents thereon, and provides that any invention made by the employee pertaining to the company's product or work shall be made known to the company or its representative, and if thought worth while by the company a patent it to be taken out at the expense of the company, which is to have exclusive right to its use so long as the inventor remains in its employ. Should he leave, however, the right ceases to be exclusive. It provides further that when the company desires to obtain full control of the invention it can do so by payment of a sum to be agreed upon, and this may be done either during the continuance of the employment or after, the company having first right to purchase within a specified time, after the expiration of which the employee is at liberty to dispose of his invention to anyone else.

The propriety of signing such an agreement, as the *American Machinist* remarks, is a matter upon which there may be some difference of opinion, but it is a matter of common knowledge that nearly all large manufacturing companies have some sort of an agreement which is made a condition of employment, and many of these contracts are by no means so liberal to the employee as the one abstracted above, and printed in full in the journal referred to. It is not the form of agreement, so much as it is the effect upon the development of the inventive faculty, of which we desire to speak.

The old idea of an inventor was that of a man who after long years of privation and

labor, succeeded in perfecting some device which he then patented and by which he soon realized a fortune. Such things have happened, and because of their remarkable nature they have naturally attracted much more attention than the innumerable instances in which men have wasted their lives in endeavoring to accomplish something which a limited knowledge of physics, chemistry, or mechanics would have shown them was impossible.

Such inventors are not unknown at the present time, but by far the greatest number of valuable inventions are developed by trained investigators, employed for the purpose by corporations who make a department of research a part of their working equipment.

That this is a system altogether desirable, or free from abuses is open to question. Thus Mr. William Stanley, in a letter originally published in the Springfield Republican, and widely reprinted, says:

"I believe the present methods adopted by the industrial trusts in dealing with the inventor, his work, his aims and rewards will, if uncontrolled in the future, annul his usefulness discourage his endeavors, disgust him with surrounding conditions, and finally remove him from the land.

"The industrial trusts now regularly employ, on salaries or by retainers, bureaus known as boards of patent control. To these boards is intrusted the problem of controlling the arts, by means of patents. They are expected to purchase such patents as they deem expedient, to manufacture any others they think necessary, to gather up fresh lines of patents wherewith to assail competitors, to bring suits against infringers, real or imaginary, and generally to operate an offensive patent campaign against competition."

At the same time it must be recognized that the modern method has its advantages, and while modifications in the legal side of patent protection may be necessary, any prevention of organized scientific research for commercial purposes could not fail to be an injury to the progress of practical science. It has been maintained that such organized research will check invention, but it is a matter of certain knowledge that many of the agreements which are required by companies of their skilled employees act to deter the latter from attempting to make any improvements in the methods or machinery of their work. No man will take the trouble to invent a new device, the rights to which he has already turned over to another. If, as is sometimes the case, an able man discovers something new and valuable, something which he thinks is really worth while, he will keep it very quiet indeed, and give up his employment without intimating that he has any ideas whatever upon the subject, and delay the application for patent protection until he is free from the entangling agreement, taking care to use only dates subsequent to his cancellation of the contract. In either case the only effect of systematic attempts of either party to overreach the other must result in a stifling of invention and a retardation of technical progress.

The essential stimulus to invention lies in the large rewards which it has hitherto held out to the successful inventor. If it is to become a daily trade, receiving only the daily wage, with possibly a small bonus, held out as a bait to encourage special effort, the great incentive will be removed, and with it much of the activity which now impels the ingenious man to put his ideas into practical shape. Since originality is not a quality which can be created at will, however much it may be developed by study and opportunity, it is evident that all methods for securing to the employer his share in the products of the inventive genius of his employees must be devised with care, or they may succeed only in suppressing all effort, a clear case of killing the goose which has laid many golden eggs.

The probable result of the changed conditions of technical development will be the advancement of the true inventor, as distinguished from the old time empiricist, and the rewards of invention will become similar in nature to those of other professional lines of work. The solution of problems which manufacturing establishments stand ready to develope according to modern commercial methods may well become an established profession, commanding large returns, and offering inducements fully equal to the practice of the law, of medicine, or even of science of destruction.

The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals if the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches

Arch Bridge Construction on the C. M. & St. P. Ry. Illustrates and describes some improvements on the La Crosse division, in Wisconsin, in the erection of stone and concrete bridges. 900 w. Ry & Engng Rev—March 14, 1903. No. 54116.

Parabolic Lines of Pressure and the Computation of Two-Hinged Arches (Ueber Parabelförmige Einflusslinien und die Berechnung des Zweigelenkbogens). H. Müller-Breslau. A discussion of the determination of the true line of pressure for two-hinged arches under various loads. 2500 w. Zentralblatt der Bauverwaltung—March 4, 1903. No. 54274 B.

Stone Arch Bridge on the Chicago, Milwaukee & St. Paul Ry. at Watertown, Wis. Illustrated description of the construction of a four-span, double-track, stone arch bridge over the Rock river without interruption of traffic. 600 w. Eng News—March 26, 1903. No. 54359.

The Construction of the Centers for the Luxemburg Arch Bridge. Illustrated detailed description of centers used for the main arch and for the shorter side arches. 1400 w. Eng News—March 5, 1903. No. 54034.

We supply copies of these articles. See page 317.

The Nine-Mile Run Steel Arch Bridge at Pittsburg, Pa. Willis Whited. Illustrated description, with explanation of the considerations governing the design, and an account of the erection of the superstructure. 3400 w. Eng News—Feb. 26, 1903. No. 53849.

Continuous Girders.

Beams with Elastic Secured Ends (Der Träger mit Elastisch Gebundenen Enden). A. Franke. A study of the resistance of continuous girders with the ends secured, subject to elastic stresses. Two articles, 4500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 7, 14, 1903. No. 54270 each D.

The Computation of Continuous Girders over Three Openings (Zur Berechnung von Kontiuierlichen Trägern ueber Drei Oeffnungen). Joh. Thieme. A mathematical treatment, deriving equations for the deflections according to the elastic theory. 1800 w. Deutsche Bauzeitung—Feb. 23, 1903. No. 54272 B.

East River, New York.

Completion of the Floor of the New East River Bridge. Illustrates and describes the work already completed. 700 w. Sci. Am—March 14, 1903. No. 54086.

The Blackwell's Island Bridge. Brief illustrated description of bridge No. 4, crossing from 59th & 60th streets, Borough of Manhattan, to the Borough of Queens. It will be the heaviest and most capacious long span bridge ever constructed, and, with one exception, the longest truss span ever built. 1500 w. Eng Rec—Feb. 28, 1903. No. 53899.

Elliptical Bridge.

A Curious Elliptical Bridge. Illustrates and describes a novel construction in the North of Ireland, erected to enable tourists to safely view the wild, picturesque scenery, and gain access to interesting caves. 800 w. Sci Am—March 21, 1903. No. 54164.

Erection.

Erection of the Northwest Miramichi Bridge, Newcastle, N. B. H. D. Bush. Read before the Canadian Soc. of Civ. Engrs. Describes this new bridge of the Intercolonial Ry., the removal of the old spans, and method of erecting the new. 2200 w. Can Engr—March, 1903. No. 53981.

Fort Dodge, Iowa.

The Chicago Great Western and the Fort Dodge Bridge. An illustrated description of a viaduct having a total length of 2,582 ft., with many features of interest. 4000 w. Ry Age—March 20, 1903. No. 54349.

Removal.

A Novel Plan for Removing a Bridge. An illustrated account of the bridge on the D., L. & W. R. R., crossing the Passaic river at Newark, N. J., where the action of the tides complicated the problem. 1400 w. Ry Age—March 20, 1903. No. 54345.

Suspension.

A Comparison Between Eye-Bar Chains and Wire Cables for Suspension Bridges. Wilhelm Hildenbrand. Showing that economy is decidedly on the side of wire cables, and criticising the alteration made in the "Manhattan" bridge. 4800 w. Eng News—March 12, 1903. No. 54090.

Report of Special Commission of Engineers on the Plans for the Manhattan Bridge, New York City. Supports Mr. Gustav Lindenthal's claims that the substitution of eye-bar chains will give increased rapidity of erection and no greater first cost. 1800 w. Eng News—March 12, 1903. No. 54094.

Trenton, N. J.

The Delaware River Bridge of the Pennsylvania Railroad at Trenton, N. J. Illustrated description of the construction of a new four-track stone arch bridge at this point, and a change in location of tracks. 2000 w. Ry Age—March 20, 1903. No. 54350.

Trestle Work.

A Railway Trestle with Bents of Reinforced Concrete. William A. Allen. Brief illustrated description of work at Perth Amboy, N. J. 800 w. Eng News—March 12, 1903. No. 54095.

Viaduct.

Results of the Tests of the Viaur Viaduct (Résultats des Epreuves du Viaduct du Viaur). Describing the manner in which the viaduct was loaded with locomotives and cars. The deflections were much less than had been computed. 1800 w. Rev Gen des Chem de Fer—Feb., 1903. No. 54258 H.

Viaduct over the Viaur. Illustrates and describes a remarkable structure which carries the railway from Carmaux to Rodez, in the south of France. It is a system of balanced arches on a scale of great magnitude. Describes methods of erection, materials, etc. 1200 w. Engr, Lond—Feb. 27, 1903. No. 54017 A.

Wheel Loads.

A Conventional System of Treating Wheel Loads. M. F. Brown. Gives results of investigations made recently by the writer of the "Two Floor-beam Maximum" method, and also other methods. 1500 w. Eng News—March 26, 1903. No. 54363.

CANALS, RIVERS AND HARBORS.

Breakwaters.

The Accident to the Buffalo Breakwater.

We supply copies of these articles. See page 317.

An illustrated account of the serious settlement that occurred Dec. 10, 1902, describing the proposed method of repairing. 600 w. Eng News—March 19, 1903. No. 54307.

The Development of Buffalo Harbor. Emile Low. From a paper before the R. R. Branch of the Y. M. C. A. Briefly reviews previous work and gives an illustrated account of the breakwater system in process of construction which will make this one of the finest harbors. 2500 w. R R Gaz—March 13, 1903. No. 54130.

Canada.

Tide Levels and Datum Planes in Eastern Canada. W. Bell Dawson. Information gathered in connection with the tidal survey regarding tidal levels and facts of importance in harbor construction, etc. 15,500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54143 D.

Canal Traction.

See Electrical Engineering, Power Applications.

Cumberland Sound, Fla.

The Improvement of the Entrance to Cumberland Sound, Georgia and Florida. James H. Bacon. Gives description of the work, with maps, and editorial on the striking contrast of the cost of the work, with that done under the Carter conspiracy. 4000 w. Eng News—March 12, 1903. No. 54093.

Dams.

A Small Rock-Fill Dam. H. deB. Parsons. Illustrated description of a dam designed to impound a gravity water supply on an estate in New Jersey and of its construction. 1500 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54379 E.

Straight-Faced Dams (Barrages à Parements Rectilignes). G. Cadart. A discussion of the distribution of pressure in masonry dams, and the construction of rectilinear sections of stability and economy. 9000 w. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54250 E+F.

Danube.

The Work on the Lower Danube between Tultscha and the Sulina Mouth (Die Arbeiten an der Unteren Donau Zwischen Tultscha und der Sulinamündung). Data concerning the dredging and other improvement works on the lower Danube in Roumania. 2500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst —Feb. 28, 1903. No. 54271 D.

Docks.

See Marine and Naval Engineering.

Dredging.

Modern Machinery for Excavating and Dredging. A. W. Robinson. The second article describes, with many illustrations, the heavier types of dredges, adapted to tidal harbors and deep waterways. 3500 w. Engineering Magazine—April, 1903. No. 54283 B.

Suction Dredging in the Estuary of the Seine (Les Dragages par Succion dans l'Estuaire de la Seine). L. Sekutowicz. An account of the deepening of the channel at the entrance to the Seine, with illustrations of the suction dredge used. 2000 w. 1 plate. Génie Civil—Feb. 14, 1903. No. 54200 D.

Twenty-In. Tydraulic Dredge King Edward. A. W. Robinson. Read before the Can. Soc. of Civ. Engrs. Illustration, with description of this dredge which is to be used for work on the Pacific coast. 2800 w. Can Engr—March, 1903. No. 53983.

Flow.

A Problem in Hydraulics (Note sur un Probleme d'Hydrauliques). Ed. Collignon. A graphical and analytical study of the action of floods in rivers and other streams 3000 w. Revue de Mécanique—Feb. 28, 1903. No. 54256 E+F.

Study of a New Formula for the Velocity of Water (Studie über eine Neue Formel Zur Ermittlung der Geschwindigkeit des Wassers). R. Siedek. An examination of a number of data of water flow in small streams and artificial channels, and the derivation of a formula including the results. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 13, 20, 1903. No. 54220 each B.

The Flow of Streams. R. S. Lea. A collection of rainfall and stream flow records, given in tables, including streams differing in extent of drainage area, geological conditions, rainfall and climate. Much related information is also given. 7 plates. 10,000 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54141 D.

Holland.

The Eems Canal and Its Accompanying Canals and Streams (Hel Eems Kanaal en de darop Afwaterende Kanalen en Rivіertjes.) D. H. S. Blaupot ten Cate. A general account of the canal system about Groningen, Holland, with map. 5000 w. 1 plate. De Ingenieur—Feb. 28, 1903. No. 54268 D.

Isthmian Canal.

The Panama Canal. Discussion of paper by George S. Morison. 7800 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54381 E.

Lock.

The New Lock at Port-a-l'Anglais on the Upper Seine (Nouvelle Ecluse à Port-a-l'Anglais sur la Haute Seine). M. Alby. With full details of the masonry construction, the operation of the gates, and the

sluices. 5000 w. 3 plates. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54249 E+F.

Mississippi.

The Yazoo River Diversion. Canal at Vicksburg, Miss. Gives the history of the project, methods of work, and illustrations. 2200 w. Eng News—March 12, 1903. No. 54089.

New York Canals.

A Deep Waterway from the Lakes to the Atlantic. A description of this proposed ship canal, with editorial making a comparison with the 1000-ton barge-canal project before the New York legislature, and favoring the Federal deep waterway. Ill. 5300 w. Eng News—Feb. 26, 1903. No. 53852.

The Canal Discussion in New York. Editorial discussion of the arguments to be brought before the New York legislature. 2000 w. Eng News—March 19, 1903. No. 54309.

Nile.

The Construction of the Asyut Dam; Nile Irrigation Works. Interesting views of this second great dam across the Nile, with official description from notes by Sir Benjamin Baker. Also editorial, drawing comparison between the rapidity of engineering construction of these great works, and the slow construction of the great municipal works of New York City. 4000 w. Sci Am—Feb. 28, 1903. No. 53843.

The New Nile Reservoir. Frederic Courtland Penfield. Reviews the history of this project, and discusses the importance of the work, some of its features and the benefits expected. 4500 w. N Am Rev—March, 1903. No. 53929 D.

The Nile Dams and Reservoir. Sir Benjamin Baker. Address before the Royal Inst. of Great Britain. An account of this great engineering work—the construction of the Nile reservoir and dam at Assouan, the barrage at Asyat, and the various supplementary works. Ill. 5000 w. Pop Sci M—April, 1903. No. 54328 C.

Tides.

Why Tidal Energy or the Force or Power of the Rising and Falling Tides Has Not Been, and Cannot Be, Economically Subservient to the Requirements of Man for Industrial Purposes. C. P. Baillairge. An examination of this subject, discussing the difficulties, and giving conclusions. 4500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54140 D.

Trent Canal.

The Trent Valley Waterway. R. B. Rogers. A brief description of a projected waterway to connect Georgian Bay on Lake Huron, with Lake Ontario, at Trenton, a distance of about 200 miles. 2000 w. Marine Rev—March 5, 1903. No. 54020.

CONSTRUCTION.

Beams.

Deep-Section Rolled Beams. An illustrated description of rolled steel I girders for structural work, made at the Differdange Steel Works in a newly invented mill which permits the production of I beams as much as 29½ in. deep by 12 in. wide. 900 w. Engr, Lond—Feb. 27, 1903. No. 54014 A.

Deflections of Beams with Variable Moments of Inertia. C. W. Hudson. Gives a general method for determining the deflections of solid-webbed girders under flexure, illustrating its application to the forms of girders most frequently met in practical bridge construction. 3800 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54380 E.

Building Construction.

Foundations and Steel Work in the Government Printing Office in Washington, D C.. Illustrated description with data relating to the construction. 3500 w. Eng Rec—March 7, 1903. No. 54048.

Earthwork.

An Exact Graphical Method for Computing Embankments and Cuttings (Genaue Zeicherixhe Ermittelung des Flächenprofiles und des Grunderwerbes). R. Schönhöfer. Developing curves from which quantities may be taken out by direct scaling. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 27, 1903. No. 54221 B.

Fireproof.

Destruction of an English Mill. Account of a fire which destroyed the Vernon cotton mill in Stockport, England, showing the inability of unprotected iron to withstand fire. Ill. 1200 w. Ins Engng—Feb., 1903. No. 53934 C.

Foundations.

The Restoration of the Foundations of the Philae Temples. An illustrated account of the underpinning made necessary to preserve the buildings against the head of water when the new reservoir is full. 1800 w. Sci Am—March 14, 1903. No. 54087.

Masonry.

Concrete Masonry. Extracts from the report of the Committee of the Am. Ry. Engng & Maintenance of Way Assn. Presents specifications for cement, recommending the use of a wet concrete. 4000 w. R R Gaz—March 27, 1903. No. 54358.

Reinforced Concrete.

Steel Concrete Construction. A. L.

Johnson. Setting forth the great advantages of reinforced concrete construction, and giving convenient working formulas for beams. 1300 w. R R Gaz—March 13, 1903. No. 54128.

Roads.

Macadam Roads and Road Specifications. Ernest McCullough. A brief review of methods used in the construction of macadamized streets, with a record of some of the difficulties encountered. 3000 w. Eng News—Feb. 26, 1903. No. 53850.

Roofs.

Economy in Roofs. A reply in part to a paper by Mr. Ewing Matheson, published on Jan. 9th, and especially discussing recent examples and their cost. 3000 w. Engr, Lond—March 13, 1903. No. 54196 A.

Tunnels.

Air-Testing in Tunnel Construction. Joseph W. Ellms. Reports concerning the use of the Shaw gas-tester, at Cincinnati. 2500 w. Eng Rec—March 7, 1903. No. 54049.

Improved Methods for Difficult Subaqueous Tunneling. Brief illustrated descriptions of some of the methods that have been proposed for the construction of important tunnels in connection with the transit systems of New York. Also editorial. Ill. 4800 w. Eng Rec—March 14, 1903. Serial, 1st part. No. 54124.

Ventilation of Subways and Tunnels. Editorial on the need of studying this subject, referring to recent articles bearing upon it, and reporting the conditions of the air. 1800 w. Eng Rec—March 7, 1903. No. 54047.

Underpinning.

Direct and Indirect Supports for Underpinning a High Wall. Brief illustrated description of method used at 56 Cedar street, New York, for underpinning a heavy wall and piers with needle beams and cantilevers. 1200 w. Eng Rec—March 21, 1903. No. 54326.

MATERIALS.

Asphalt.

Asphalt Refining. Prof. W. R. Crane. Illustrated article describing methods employed in the Tar Springs Asphalt Co.'s refinery, near Comanche, Ind. T. 4700 w. Mines & Min—March, 1903. No. 53974 C.

Brick.

An Investigation of the Properties of Brick, Under Different Physical Conditions. Sherman M. Turrill. An illustrated account of tests conducted at Cornell University, giving the methods of procedure, the results of the tests, and an outline of the conclusions. 8000 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54378 E.

Cement.

The Passing of Natural Rock Cement. F. H. Doremus. A discussion of the decadence of this industry and the causes. 2000 w. Am Archt—March 28, 1903. No. 54398.

Concrete.

Note on the Coefficient of Elasticity of Concrete and Mortar Beams During Flexure. Myron S. Falk. Gives valuable results for concrete and mortar beams tested to the point of failure. 600 w. Pro Am Soc of Civ Engrs—Feb., 1903. No. 53-950 E.

The Constituent Parts of Concrete. Abstract of a paper by Charles M. Crawford, read before the Connecticut Soc. of Civ. Engrs. Considers methods of testing followed by various engineers, the mixtures used, etc. 2300 w. Eng Rec—March 7, 1903. No. 54052.

Mortar.

The Decomposition of Mortar (Décomposition des Mortiers). J. Bied. An examination of the decomposing action of water charged with sulphate of lime upon mortar, citing important examples. 5000 w. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54252 E+F.

Preservation.

The Preservation of Materials of Construction. An interesting informal discussion of this subject. Ill. 11300 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54382 E.

Steel Protection.

The Preservation of Steel. An illustrated description of the condition of the steel frame work found in the demolition of the Pabst Building in New York City. The conclusion reached is that concrete is a very efficient protection. 900 w. Ins Engng—Feb., 1903. No. 53933 C.

Stone.

The Stone Resources of South Dakota. An illustrated account of the quarrying industry of this state and facts in regard to the stone resources and building material. 1500 w. Stone—March, 1903. No .54-145 C.

Timber.

Fungi, Merulius Lacrymans, and other Growths Injurious to Timber (Ueber Hausschwarum, Merulius Lacrymans, und andere Holzzerstorende Pilze). Dr. H. Zikes. A study of the diseases of timber as affecting its use for structural purposes, discussing various preservatives. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—March 6, 1903. No. 54222 B.

Tests of the Relation Between Cross Bending and Direct Compressive Strength in Timber. Clarence A. Martin. An ac-

count of tests made at Cornell University, with tabulated results. 1500 w. R R Gaz —March 13, 1903. No. 54129.

The West Pascagoula Creosoting Works. Illustrated description of this important plant in Mississippi, for treating piles, wharf timbers, bridge timbers, cross ties, cutout and foundation timbers of all sizes, ship timbers, etc. 1800 w. Ry & Engng Rev—March 14, 1903. No. 54118.

MEASUREMENT.

Level Rod.

A New "Automatic" Level Rod. Illustrates and describes a recent patent in which the rod reading itself is the cut, fill or elevation. 1000 w. Eng News—March 12, 1903. No. 54092.

Metric System.

See Mechanical Engineering, Measurement.

MUNICIPAL.

Fire Protection.

Existing Laws, By-Laws, and Regulations Relating to Protection from Fire, with Criticisms and Suggestions (Fothergill Prize Essay). T. Brice Phillips. An outline of British laws as to fire protection, explaining the principle underlying them, and considering the subject generally. Also papers by George H. Paul, and by W. Craig Henderson, on this subject. with discussion. 2500 w. Jour Soc of Arts—March 13, 1903. No. 54180 A.

Garbage.

Some Features of the New Garbage Reduction Works at Buffalo, N. Y. Slightly condensed paper by C. A. Blessing describing some parts of these reduction works. 700 w. Eng News—Feb. 26, 1903. No. 53855.

Pavements.

Coal Tar Pavements. Allan Wade Dow. An illustrated article claiming remarkably low cost for repairs, and reporting in regard to pavements over thirty years old, and their methods of construction. 3000 w. Munic Jour & Engr—March, 1903. No. 53966 C.

How to Lay Brick Pavements. Ira O. Baker. An illustrated article considering details of construction, and the merits of this kind of pavement. 2700 w. Munic Jour & Engr—March, 1903. No. 53964 C.

Medina Block Stone Pavements. E. A. Fisher. Gives good points of this pavement and model methods of construction. Ill. 4000 w. Munic Jour & Engr—March, 1903. No. 53961 C.

Pavements for Small Cities. F. F. Rogers. Considers streets and roads where expensive pavements are not warranted, recommending well-constructed macadam. Ill. 1800 w. Munic Jour & Engr—March, 1903. No. 53965 C.

The Bitulithic Pavement. Walter B. Warren. A statement of its advantages, claiming that it possesses the good qualities of macadam without the defects. Ill. 3000 w. Munic Jour & Engr—March, 1903. No. 53962 C.

Wood Paving in England and America. F. A. Kummer. Gives information of the classes of wood used, and the methods, serviceability, etc. Ill. 2000 w. Munic Jour & Engr—March, 1903. No. 53963 C.

Refuse.

The Sanitary Disposal of Municipal Refuse. Informal discussion by Messrs. Falk, Baker, Baldwin and Parsons. 4000 w. Pro Am Soc of Civ Engrs—Feb., 1903. No 53951 E.

The Sanitary Disposal of Municipal Refuse. Continued informal discussion of this subject. Ill. 10000 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54383 E.

Sewers.

Crossing Under the Sudbury Aqueduct with a Sewer Pipe. Charles W. Sherman. Describes two plans submitted, and gives detailed description of the work of construction of the accepted plan. Ill. 1700 w. Eng Rec—Feb. 28, 1903. No. 53901.

Detroit Sewer System. W. C. King. Brief description of the gravity system in use, and the construction. 1400 w. Jour Assn of Engng Socs—Jan., 1903. No. 54160 C.

Shone Ejector Plant at Worcester, Mass. Harrison P. Eddy. Describes the schemes for disposal of sewage in this district, especially the plant for the Worcester Highlands. 1200 w. Eng Rec—Feb. 28, 1903. No. 53902.

Statistics.

Analysis of the Seventh Annual Report of the Public Lighting Commission, Detroit, Mich. A critical analysis with editorial comments. 7500 w. Elec Wld & Engr—Feb. 28, 1903. No. 53956.

Storm Water.

The Measurement of Rainfall and Run Off (Ueber Regenhöhen und Abflussmengen). Prof. Büsing. A discussion of the probable rainfall in cities and the volume of storm water to be provided for by the sewage systems. 5000 w. Gesundheits-Ingenieur—Feb. 28, 1903. No. 54263 B.

WATER SUPPLY.

Filtration.

Automatic Modules for Regulating the Speed of Filtration. Charles Anthony, Jr. Considers the requirements which an apparatus of this kind should fulfil, and describes various forms of controller designed for this purpose. Ill. 1400 w. Pro

We supply copies of these articles. See page 317.

Am Soc of Civ Engrs—Feb., 1903. No. 53949 E.

Slow Sand Filtration Plant for Washington, D. C. J. S. Schultz. An illustrated description of the proposed plant, with brief account of the investigations that led to its recommendation. 3500 w. Eng Rec—March 14, 1903. No. 54123.

The Filtration Works of the East Jersey Water Company, at Little Falls, New Jersey. George W. Fuller. History of the undertaking, general description of the pumping station, and detailed description of the filtration works and their operation, with illustrations. 6500 w. Pro Am Soc of Civ Engrs—Feb., 1903. No. 53948 E.

The New Philadelphia Filtration System. H. D. Jones. An illustrated article explaining how the beds are made and how the filtering is done. 1400 w. Sci Am—March 14, 1903. No. 54084.

Fire Service.

The Relation of Water-Works Engineers to the Fire Service of Factories. Edward Atkinson. A discussion of the fire service of textile, factories, paper mills, machine shops, etc., and the need of co-operation between water-works engineers and underwriters; inspectors; meters, etc. General discussion. 12000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54389 F.

Hydrants.

Hydrant Rental. D. H. Sawyer. A discussion of what is an equitable and just charge. 1800 w. Munic Engng—March, 1903. No. 53943 C.

Irrigation.

Administration of Streams in Irrigation. Elwood Mead. Considers the relation of streams to the agricultural development of the west, the meaning of a water right, etc. Also discussion. 7300 w. Jour W Soc of Engrs—Feb., 1903. No. 54149 D.

The Flood Reservoir at Fossil Creek. Illustrations, with report of this reservoir demonstrating the feasibility of this class. 900 w. Sci Am Sup—March 28, 1903. No. 54367.

Municipal Ownership.

City Ownership of Water Supply. William R. Hill. An account of the success attained at Syracuse, N. Y., as related in a paper read before the City Reform Club of New York. 2000 w. Fire & Water—March 7, 1903. No. 53952.

Organisms.

Removal of Color, Organisms, and Odor from Water. H. W. Clark. Describes some filtration experiments, the main object of which was the removal from water of coloring matter, odors, and the organisms producing odors. 3000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54384 F.

Pollution.

Polluted Waters Round New York. Discusses the available sources of supply around New York city, and the pollution that renders many of the watersheds useless, especially the contamination of the Passaic in northern New Jersey. Ill. 2500 w. Fire & Water—March 7, 1903. No. 53953.

Properties.

The Physical Properties of Water. Allen Hazen. Considers the appearance of water due to foreign matters which it contains, and describes apparatus for measuring the color of water and urges the keeping records of colors and turbidity. General discussion. 4000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54386 F.

Water Pipe.

Laying 6-ft. Concrete-Jacketed Riveted Steel Pipes Under the Hackensack and Passaic Rivers. Brief illustrated description of the method of submerged work used. 600 w. Eng News—March 12, 1903. No. 54091.

Standard Specifications for Cast-Iron Pipe and Special Castings. Gives the tables of special castings which were lacking in the article published in Dec., 1902, that the record may be complete. 1200 w. Jour N Eng W-Wks Assn—March, 1903. No. 54390 F.

Water Tower.

The Gorter Water Tower. Illustrated description of a "water tower" belonging to the fire apparatus of San Francisco, which has very novel features. 1500 w. Sci Am—March 14, 1903. No. 54085.

Water-Works.

Opening of the Coolgardie Water-Works. An account of these recently opened water-works of Western Australia, which, it is hoped, will greatly benefit the goldfields. Explains the needs of the gold fields, and the importance of this great undertaking. 3700 w. Engr, Lond—March 13, 1903. No. 54300 A.

MISCELLANY.

Laboratory.

The National Physical Laboratory and Engineering. Dr. R. T. Glazebrook. Lecture to the graduates of the Inst. of Mech. Engrs. Illustrates and describes the equipment of this laboratory, and suggests the work, useful to engineers, which may be done there. 4200 w. Engng—March 13, 1903. Serial. 1st part. No. 54195 A.

Sand Blasting.

Sand-Blast Cleaning of Structural Steel. George W. Lilly. Gives some of the results which have been attained, and data as to the cost and other elements entering into its application. 7500 w. Pro Am Soc of Civ Engrs—Feb., 1903. No. 53947 E.

We supply copies of these articles. See page 317.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Exchange.

An Automatic Telephone Operator. William J. Hammer. A description of an automatic telephone exchange operator, power driven, which performs the functions of switching, signalling, line-clearing, etc., of the human operator, and by exactly similar means. Also a comparison of the salient features of the manual and automatic systems. Ill. 7000 w. Trans Am Inst of Elec Engrs—Feb., 1903. No. 54392 D.

Cables.

Some Interesting Experiences Connected with the Manipulation and Installation of Cables. H. W. Fisher. Brief notes on telephone and electric light cables. 1000 w. Pro Engrs Soc of W Penn—Jan., 1903. No. 54153 D.

The Ratio of Resistance to Capacity in Long Submarine Cables, and Some Related Quantities. J. Elton Young. The first part of an interesting paper on the core ratio of submarine cables, with editorial. 4000 w. Elect'n, Lond—March 6, 1903. Serial. 1st part. No. 54105 A.

Cable Ships.

See Marine and Naval Engineering.

Coherer.

The Branly Coherer. C. L. Durand. An account of the Branly-Popp aerial telegraphy system which is to supply news in Paris, to subscribers. Special description of the coherer used. Ill. 1600 w. Elec Rev, N Y—March 7, 1903. No. 54028.

Detector.

A Magnetic Apparatus Adapted for the Detection of Electric Waves (Sur un Appareil à Effet Magnétique propre à Servir de Détecteur d'Ondes Electriques). C. Tissot. An account of the detector of Marconi, and the experiments of Rayleigh and Rutherford. 1200 w. Comptes Rendus—Feb. 9, 1903. No. 54211 D.

Small Exchanges.

The Relative Merits of Central Energy and Magneto Telephone Systems in Small Exchanges. W. A. Taylor. Read before the Wisconsin Ind. Telephone Assn. Calls attention to some of the advantages of each system. 1100 w. Elec Rev, N Y—Feb. 28, 1903. No. 53898.

Space Telegraphy.

Bull's Electric System of Wireless Telegraphy. A. Frederick Collins. Illustrates and describes the system of Mr. Anders Bull which operates mechanically and in which a fixed number rate of wave impulses actuate different receiving instruments in accordance with prearranged time intervals. 2000 w. Sci Am—March 21, 1903. No. 54162.

Hertzian Wave Telegraphy. Abstract of the first of a series of lectures by Prof. J. A. Fleming, before the Soc. of Arts. Aims to give a summary of the present state of knowledge on the subject. An exposition of the principles of the Hertzian wave telegraphy. 4500 w. Engng—March 6, 1903. No. 54107 A.

On a New Process for Tuning Spark Telegraph Stations. Count Arco. Abstract from *Elektrotechnische Zeitschrift*. Treats of a method of standardizing the sets of apparatus supplied to ships desirous of communicating with differently-tuned shore stations. Ill. 1700 w. Elect'n, Lond—Feb. 27, 1903. No. 54009 A.

Portable Wireless Telegraph Equipments in the German Army. A. Frederick Collins. Illustrated description of the special apparatus constructed by the Braun-Seimens & Halske Co., to withstand the harsh treatment and strenuous conditions of army service. 900 w. Sci Am Sup—Feb. 28, 1903. No. 53845.

The Effect of Wireless Radiation on Aerial Conductor Systems. Joseph B. Baker. Refers to the troubles on telephone and telegraph lines when electric railways were first operated, and discusses some of the effects that may be caused by the energy radiated through space. 1800 w. Elec Rev, N Y—March 21, 1903. No. 54316.

Tuned Wireless Telegraph Circuits. A. V. Thiessen. Extract from a paper in the U. S. *Monthly Weather Review*, dealing with tuned circuits. 1000 w. Elec Wld & Engr—March 7, 1903. No. 54058.

Wireless Telegraphy. C. Arldt. Gives a summary of the first principles of electricity and magnetism, needed to understand the subject; illustrated descriptions of apparatus and instruments used; a brief account of Marconi's first wireless telegraph and its operation; of the Slaby, Braun, and other systems; noting the stations already established and what they have accomplished. 11000 w. Trac & Trans—March, 1903. No. 54110 E.

Wireless Telegraphy for Military Purposes. Arthur Wilke. Abstract of an article in the *Elektrotechnische Zeitschrift*. An illustrated description of Braun's Apparatus for military signalling. 2000 w. Elect'n, Lond—Feb. 27, 1903. No. 54008 A.

We supply copies of these articles. See page 317.

Switchboard.

The Evolution of the Telephone Switchboard. Thomas D. Lockwood. Historic account of the development of the telephone exchange and an analysis of the mechanical and electrical features of telephone switchboard apparatus from 1877 to date. Ill. 9000 w. Trans Am Inst of Elec Engrs—Feb., 1903. No. 54391 D.

Telephony.

Experiments in Long-Distance Telephony on the Pupin System. F. Dolezalek and A. Ebeling. From the *Elektrotechnische Zeitschrift*. Describes investigations made to ascertain to what extreme the improvement shown by theory in consequence of adding self-induction was actually attained in practice. 2000 w. Elect'n, Lond—Feb. 20, 1903. Serial, 1st part. No. 53863 A.

Discussion. A discussion of the papers by Thomas D. Lockwood and by William J. Hammer. 12,500 w. Trans Am Inst of Elec Engrs—Feb., 1903. No. 54393 D.

DISTRIBUTION.

California.

The Distribution of Bay Counties Power. The first of a series of illustrated articles showing how the power of this great corporation is to be utilized. The present article relates to Marysville and its industries. 6000 w. Jour of Elec—Feb., 1903. Serial, 1st part. No. 54111 C.

High Tension.

The Use of High Tension Underground Conductors. Henry Floy. Discusses the slow introduction of high-tension cable, the cause, the advantages, etc. 2000 w. Elec Wld & Engr—March 7, 1903. No. 54060.

Losses.

Distribution Losses in Electric Supply Systems. A. D. Constable and E. Fawssett. Abstract of a paper read before the Inst. of Elec. Engrs. Gives figures referring to the Croyden electricity works, discusses the losses and whether it is possible to reduce them. The present article considers switchboard and cable losses. 1000 w. Elect'n, Lond—March 13, 1903. Serial, 1st part. No. 54302 A.

Rectifier.

New Form of Electrolytic Apparatus for Rectifying Alternating Currents. C. L. Durand. An illustrated description of apparatus invented by M. Nodon, of Paris. 2000 w. Elec Rev, N Y—March 14, 1903. No. 54078.

Switches.

A New Spark-Preventing Device for Battery Switches (Ueber eine Neue Funkenentziehvorrichtung an Zellenschaltern). Paul Thieme. Describing the use of an auxiliary switch arrangement, preventing the sudden interruption of the current. 2000 w. Elektrotech Zeitschr—Feb. 12, 1903. No. 54235 B.

ELECTRO-CHEMISTRY.

Cells.

Solid Electrolyte Cells. A. L. Marsh. Reviews briefly the results of various experimenters and the work of the writer. 1500 w. Electro-Chem Ind—March, 1903. No. 54157 C.

Classification.

Notes on a Classification of Electro-Chemistry. Clinton Paul Townsend. Gives an outline classification dealing with the technical applications of the subject, with notes. 1500 w. Electro-Chem Ind—March, 1903. Serial, 1st part. No. 54156 C.

Electric Smelting.

Electric Manufacture of Steel. George E. Walsh. Describes the furnaces at Kerrousse, France, for the treatment of iron and steel. 1600 w. Am Elect'n—March, 1903. No. 54031.

The Electro-Metallurgical Production of Iron and Steel. Describes various designs of electric furnaces and processes which are being tried for the reduction of iron ore and direct production of steel in one operation. Ill. 1700 w. Engr, Lond—March 13, 1903. No. 54301 A.

Lake Superior.

The Industries of the Consolidated Lake Superior Company. E. G. M. Cape. An account of what this company has done, showing how its different industries are bound together. Chiefly considers the electrochemical industries on the Canadian side of the St. Mary's river. 11 plates. 9500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54142 D.

Refining.

The Electrolytic Refining of Silver and Gold. Titus Ulke. An illustrated description of different methods and some of the advantages of each. 4800 w. Mines & Min—March, 1903. No. 53977 C.

ELECTRO-PHYSICS.

Conversion.

The Conversion of Electrical Energy to Other Forms. Arthur L. Rice. Read before the James Watt Assn. Considers briefly the conversion into heat, light and mechanical motion. 1500 w. Engr, U S A —March 2. 1903. No. 53909.

Discharge.

The Electrical Conductivity and Absorption of Energy in the Electrodeless Discharge. Bergen Davis. An illustrated account of experiments made to measure the conductivity produced in gases by the

discharge at various pressures. 1300 w. Am Jour of Sci—March, 1903. No. 53940 D.

Magnetism.

The Causes of Magnetism (Die Ursachen des Magnetismus). T. Zacharias. A study of magnetic curves produced with metal filings, with a discussion of the laws of their formation. 3000 w. Glasers Annalen—March 1, 1903. No. 54226 D.

Magnets.

The Effects of Changes of Temperature on Permanent Magnets. Hiram B. Loomis. An account of some experiments undertaken to determine more accurately the kind of change that takes place when a magnet is heated and cooled after it has been brought to the "permanent state." 4800 w. Am Jour of Sci—March, 1903. No. 53939 D.

Radio-Activity.

Radium—Its Extraordinary Properties. C. W. Kanolt. An interesting account of the discovery, the properties, cost, and action. 1800 w. Sci Am—Feb. 28, 1903. No. 53842.

The Radiations of Polonium and Radium (Sur la Rayonnoment du Polonium et du Radium). H. Becquerel. An examination of the experiments of Rutherford as to the deviability of the rays from radiant metals; with an account of the writer's experiments. 1800 w. Comptes Rendus—Feb. 16, 1903. No. 54212 D.

Resonance.

A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms. M. B. Field. Abstract of a paper read before the Glasgow Soc. of the Inst. of Elec. Engrs. The present number considers the conditions under which electric resonances may occur. 2000 w. Elec Rev, Lond—March 6, 1903. Serial, 1st part. No. 54102 A.

GENERATING STATIONS

Commutators.

Some Notes on Commutator Design. T. Square. Considers the electrical conditions to be satisfied, and also the mechanical features. Ill. 4200 w. Elec Engr, Lond—March 13, 1903. No. 54189 A.

Eastbourne.

Eastbourne Electricity Works. Illustrated detailed description of new English works. 4200 w. Elec Engr, Lond—March 6, 1903. No. 54100 A.

Hydro-Electric.

A Hydro-Electric Power Plant in Newfoundland. Earl E. Boardway. Brief illustrated description of the plant which furnishes power for St. John's, nine miles distant. 1000 w. Elec Wld & Engr—March 7, 1903. No. 54057.

A Swiss Combined Water-Power and Gas Engine Plant. An illustrated description of a water-power station at Goldach with auxiliary gas-engine plant at St. Gall. 2000 w. Am Elect'n—March, 1903. No. 54029.

A Water-Power Plant Near Grenoble, France. Brief description of a plant, chiefly interesting from the fact that it uses a hooped-steel concrete conduit for conducting the water. 2500 w. Eng Rec—March 7, 1903. No. 54051.

Rise of Water Power in Electrical Supply. Alton D. Adams. Shows the development of water power for electrical supply to be gaining very rapidly, giving information of the transmission systems. 1000 w. Sci Am—March 28, 1903. No. 54365.

The Hydro Electric Station of Côtes de Sassange (Usine Hydro-Electrique des Côtes de Sassange). A. Mauduit. Describing a small station on the Isère above Grenoble, utilizing a head of 135 metres; operating in connection with the larger station at Engins. 1800 w. Génie Civil—March 7, 1903. No. 54205 D.

Water-Power Electric Plant at Manchester, Conn., for the Cheney Bros.' Silk Mills. Earl E. Boardway. An illustrated detailed description of this plant. 1500 w. Eng News—March 19, 1903. No. 54306.

Isolated Plant.

Power Plant of the Wells Building, Milwaukee. Illustrates and describes a fine plant installed in a high office-building, and having a capacity about double of the requirements of the building, to furnish lighting and steam service to neighbors. 3200 w. Engr, U S A—March 2, 1903. No. 53908.

Parallel Driving.

The Pendulum Action of Alternators in Parallel (Das Pendeln Parallel Geschalteter Wechselstrommaschinen). Dr. G. Benischke. A discussion of the analogy of the phenomena of alternators in parallel to the oscillations of pendulums. 4000 w. Elektrotech Zeitschr—March 12, 1903. No. 54239 B.

Power House Equipment.

Some Notes on Continental Power-House Equipment. H. L. Riseley. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrated description of stations examined during a recent visit. 4800 w. Elec Engr, Lond—Feb. 20, 1903. No. 53866 A.

Stock Yards.

Swift & Co.'s Chicago Central Power Plant. An illustrated description of a 2800 H. P. electric generating station at the Union Stock Yards. 3500 w. Steam Engng—March 10, 1903. No. 54073.

See also Street and Electric Railway.

We supply copies of these articles. See page 317.

LIGHTING.

Arcs.

Flame Arc Lamps and Intensive Flame Arc Lamps of the A. E. G. (Flammenbogen lampe und Intensivflammenbogen lampen der Allgemeinen Electrizitäts-Gesellschaft). J. Zeidler. A description of improved arc lamps of high efficiency, using impregnated carbons. 4000 w. Elektrotech Zeitschr—Feb. 26, 1903. No. 54237 B.

Delhi.

Electric Lighting at the Delhi Durbar. Brief illustrated description of the arrangements for electric lighting of this temporary city, showing the magnitude of the undertaking. 1200 w. Elect'n, Lond—March 6, 1903. No. 54103 A.

Dublin.

Some Notes on the Electric Lighting of Rathmines. G. H. Pilditch. Read before the Dublin Sec. of the Inst. of Elec. Engrs. A description of the important details of the lighting system of a suburb of Dublin. 5500 w. Elec Engr, Lond—Feb. 27, 1903. No. 54005 A.

Mercury Arc.

Radient Efficiency of the Mercury Arc. Prof. William C. Geer. Condensation of a paper in the Feb. issue of the *Physical Review*, giving results of investigations. 1200 w. Elec Wld & Engr—Feb. 28, 1903. No. 53955.

Municipal Lighting.

Municipal Electric Lighting Opposed. James Blake Cahoon. Read at Nat. Con. on Munic. Ownership and Pub. Franchises. A discussion of the trials made in the United States and the conclusions reached. 4000 w. Elec Rev, N. Y.—March 14, 1903. No. 54076.

Nernst Lamp.

The Nernst Lamp. Abstract of a paper by J. Stöttner, and of the discussion. Also gives an abstract of a report of tests made of Nernst lamps for street lighting. 5000 w. Elect'n, Lond—March 6, 1903. No. 54104 A.

Street Lighting.

Incandescent Street Lighting. Alton D. Adams. Information in regard to the incandescent electric lamps used for street lighting in Massachusetts, and the value of the service. 1300 w. Munic Engng—March, 1903. No. 53942 C.

Street Lighting Conditions in New York City and a Proposed Municipal Plant. Reprint of two reports submitted to the Board of Estimate and Apportionment of New York City, with account of steps being taken to secure municipal ownership of the lighting service, or marked reduction in the cost. 7500 w. Eng News—March 19, 1903. No. 54308.

MEASUREMENT.

Alternating Currents.

A Method of Measuring Powerful Alternating Currents (Sur une Methode de Mesure des Courants Alternatifs Intenses). MM. Janet & Illovici. A description of the work done at the Central Electrical Laboratory, using a modification of the Kelvin balance. 7000 w. Bull Soc Int Elec—Feb., 1903. No. 54277 H.

Electroscope.

Elster and Geitel's Improved Form of Exner's Electroscope. A. Frederick Collins. Illustrated description of apparatus adapted for open air researches, in determining the radio-activity of air and indicating the electrification. 1400 w. Elec Wld & Engr—March 7, 1903. No. 54059.

Meter Testing.

The Testing of Recording Wattmeters on the Consumer's Premises by Means of a Specially Constructed Portable Test Meter. W. J. Mowbray. Describes a method of testing meters in place, by using a peripatetic standard meter similar to the meter tested. Ill. 3200 w. Elec Wld & Engr—March 21, 1903. No. 54311.

Permeability.

The Investigation of Sheet Iron (Zur Untersuchung von Eisenblechen). Dr. G. Brion. An account of methods for investigating the magnetic properties of sheet iron, with respect to its use in electrical machinery. 2000 w. Elektrotech Zeitschr—March 5, 1903. No. 54238 B.

Permeameter.

A Universal Permeameter (Permeametre Universel). R. V. Picou. Giving details of the connections and methods of using the instrument, by means of which the magnetic permeability of iron for use in electrical machinery may be accurately determined. 2000 w. L'Electricien—Feb. 21, 1903. No. 54273 B.

Photometry.

Notes on Working with an Illumination Photometer. Henry Fowler. Read before the Manchester Dist. Inst. of Gas Engrs. On types of photometers and methods of using them. 3800 w. Gas Wld—March 14, 1903. No. 54187 A.

Working an Illumination Photometer. Henry Fowler. Read before the Manchester Dist. Inst. of Gas Engrs. Addendum to a previous paper, giving record of curves of outdoor and indoor lighting. Discussion. 2400 w. Jour Gas Lgt—March 17, 1903. No. 54400 A.

Speed Indicator.

A New Speed Indicator (Ein Neuer Geschwindigkeitsmesser). G. Dettmar. Describing a device for indicating directly the speed of a railway train, or the like. A

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small dynamo is arranged so that the voltage varies directly as the speed, and is connected to a voltmeter graduated to read the speed directly. 2000 w. Glasers Annalen—March 1, 1903. No. 54224 D.

Testing.

The Magnetic Link in Plant Testing. George S. Macomber. Briefly describes the method of testing and the auxiliary apparatus necessary. 2000 w. Sib Jour of Engng—March, 1903. No. 54151 C.

Units.

A Modification in the System of Absolute Units (Ueber eine Aenderung des Absoluten Masssystemes). Dr. G. Dompieri. A discussion of the absence of uniformity in the units of mass and time, with suggestions as to a new two-dimensional system. 2500 w. Zeitschr f Elektrotechnik—March 8, 1903. No. 54243 D.

POWER APPLICATIONS.

Canal Traction.

Electric Haulage on the Miami & Erie Canal. An illustrated detailed description of the first three-phase traction system in the United States. The most extensive application of mechanical canal-boat haulage yet installed. Also editorial. 5300 w. St Ry Rev—March 20, 1903. No. 54338 C.

The New Ganz System of Electric Canal Haulage. G. Szasz. An illustrated description of the main characteristics of this system. 5500 w. Feilden's Mag—March, 1903. No. 54369 B.

Electric Motors.

The Development and Use of the Small Electric Motor. Fred M. Kimball. The first of a series of articles treating of the applications of electric motors of moderate size in all branches of engineering work. The present article discusses progress in design, introduction, and running economy, and is profusely illustrated. 4000 w. Engineering Magazine—April, 1903. No. 54284 B.

The Electric Motor. A. E. MacCoun. From Boston *Journal of Commerce*. Gives facts showing how the use of electricity is being developed about steel works and blast furnaces. 1500 w. Sci Am Sup—March 7, 1903. No. 53970.

Induction Motors.

The Heyland Induction Motor. Boy de la Tour. Reprint of a chapter specially written for the American edition of the author's work. Explains the nature of this invention and gives a method of calculation for a machine designed to meet certain requirements. 1500 w. Elec Wld & Engr—March 14, 1903. No. 54122.

Machine Driving.

Electric Shop Drive. W. R. Layman. Outlines the various methods of electric shop driving; introductory to a general discussion of their relative merits. 8200 w. Jour Assn of Engng Socs—Jan., 1903. No. 54159 C.

The Application of Motors to Machine Tools. Charles Day. Supplementary to paper read before the N. Y. Elec. Soc. Discusses some details bearing upon the equipping machines with individual motors. 1400 w. Am Mach—March 26, 1903. No. 54357.

The Possible Developments of Electrical Driving in Factories Due to the Supply of Electricity at Cheap Rates by Large Power Companies. J. S. Highfield. Abstract of paper before the Manchester Sec. of the Inst. of Elec. Engrs. A discussion of cost, advantages, and matters relating to electric driving. 4000 w. Prac Engr—Feb. 27, 1903. Serial. 1st part. No. 53992 A.

Mine Pumps.

Electric Mine Pumping at the Gneisenau Shaft (Elektrische Wasserhaltungsanlage auf Zeche Gneisenau). K. Nowak. A description of the 640 h. p. electric pumping plant, with induction motor, at the Gneisenau mine near Dortmund. 1500 w. Glückauf—Feb. 28, 1903. No. 54232 D.

Mining Work.

Application of Electricity to Mining. Daniel Burns. Read before the Glasgow Tech. Col. Sci. Soc. Deals with some of the more important applications of electricity for mining purposes, such as lighting; driving machinery; coal-cutting; drilling; separating minerals; shot-firing; signalling, etc. 1700 w. Col Guard—Feb. 20, 1903. Serial. 1st part. No. 53874 A.

Electrical Mining Notes. Sidney F. Walker. The present article considers the uses of electricity in British collieries. 2000 w. Elec Rev, N. Y.—March 14, 1903. Serial. 1st part. No. 54075.

Electricity in Modern Mining Drainage Installations. Frank C. Perkins. An illustrated article concerning the reliability and economy of electrically operated pumps, and the use of electricity for mine haulage, hoisting, etc. 1500 w. Sci Am—March 28, 1903. No. 54366.

Motor Design.

Design for a ½-H. P. Self-Starting Single-Phase Induction Motor. Drawings and description of all the essential features. 1800 w. Am Elect'n—March, 1903. No. 54032.

Motor Loads.

Motive Power Supply from Central Stations. R. A. Chattock. Abstract of a paper before the Leeds Sec. of the Inst. of Elec. Engrs. and of the discussion. Treats of the motor load of electricity supply sta-

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tions and the cost of generation. 3500 w. Elect'n, Lond—Feb. 27, 1903. No. 54010 A.

Naval Service.

See Marine and Naval Engineering.

Railway Station.

Power Equipment of the Pennsylvania Union Station, Pittsburg. Drawings and description of interesting features. 2200 w. Eng Rec—March 21, 1903. No. 54327.

Synchronous Motors.

An Analysis of the No-Load Current of Synchronous Motors (Analyse des Leerlaufstrommes von Synchronmotoren). E. Rosenberg. With diagrams showing the variations in phase curves under different conditions. 3000 w. Elektrotech Zeitschr—Feb. 12, 1903. No. 54234 B.

See also Street and Electric Railways.

TRANSMISSION.

Circuits.

Copper Calculations for Polyphase Circuits. George T. Hanchett. Gives methods of computing for various cases. 1300 w. Cent Sta—March, 1903. No. 54071.

Composite Transmission.

Some Engineering Features of the Bedell System of Composite Transmission. A. S. McAllister. Gives illustrated detailed description of methods for the joint transmission of direct and alternating currents of two frequencies. Also editorial. 3000 w. Elec Wld & Engr—Feb. 28, 1903. No. 53954.

Conductors.

Electric Transmission Lines. Alton D. Adams. A discussion and comparison of line wire materials. 3500 w. Cassier's Mag—March, 1003. No. 54137 B.

Continuous Current.

Continuous Current for Power Transmission. Alton D. Adams. Considers systems of transmission by continuous current, showing that they should cost less for equipment than the alternating for power alone, and discussing their advantages. 3000 w. Elec Rev, N. Y.—March 21, 1903. No. 54315.

Five-Phase.

A Theoretical Treatment of a Five-Phase System (Theoretische Behandlung eines Fünfphasenstromsystemes). E. W. Ehnert. An application of the vector analysis to the study of a proposed polyphase system. 2500 w. Zeitschr f Elektrotechnik—Feb. 15, 1903. No. 54241 D.

High Tension.

The 22,000-Volt Transmission Installation Supplying Current to Mines by the Northern California Power Company. Frank C. Perkins. Illustrated description of a recently completed high tension service in Northern California. 1700 w. Min Rept—March 26, 1903. No. 54396.

Insulators.

The Use of Porcelain in the Manufacture of High and Low Tension Switchgears. W. E. Warrilow. On the importance of this product as an insulator. 2000 w. Elec Engr, Lond—March 13, 1903. No. 54190 A.

MISCELLANY.

Protection Device.

A Protecting Device Against the Dangers of High Voltage Currents (Ueber eine Schutzkleidung gegen die Gefahren Hoher Spannungen). N. Artemieff. Describing a garment with hood and sleeves of woven metallic fabric, preventing the discharge from injuring the operator. 2000 w. Elektrotech Zeitschr—March 12, 1903. No. 54240 B.

Report.

Safety Regulations for the Installation of Heavy Currents (Sicherheitsvorschriften für die Errichtung Elektrischer Starkstromanlagen). The report of the commission of the Verband Deutscher Elektrotechniker. 10,000 w. Elektrotech Zeitschr—Feb. 19, 1903. No. 54236 B.

GAS WORKS ENGINEERING

Acetylene.

Acetylene. John W. Woodall and F. Windham. Read before the Soc. of Architects. Gives the history and chemical composition of carbide of calcium from which the gas acetylene is generated, and the system of generators, costs, installations, etc. 3200 w. Archt, Lond—Feb. 20, 1903. No. 53862 A.

Ammonia.

Ammonia Concentration at Gas Works. John S. Unger. Read at meeting of the Wisconsin Gas Assn. Illustrates and explains a suitable apparatus for ammonia concentration, and its operation. 1600 w. Am Gas Lgt Jour—March 2, 1903. No. 53891.

Artificial Lighting.

Artificial Lighting in the Nineteenth Century. Abstract of a paper by D. Macfie, read before the Edinburgh Archt. Assn. Mainly historical with special reference to Edinburgh. 3500 w. Jour Gas Lgt—March 10, 1903. No. 54179 A.

We supply copies of these articles. See page 317.

Cyanogen.

German Progress in the Recovery of Cyanogen from Gas. Substance of articles recently appearing in German technical journals, notably the *Jour. für Gasbeleuchtung*, dealing with processes for the extraction of cyanogen from coal gas. 4000 w. Jour Gas Lgt—Feb. 24, 1903. Serial. 1st part. No. 53958 A.

Edinburgh.

Edinburgh's New Gas Works. An illustrated description of the first section of these fine works, recently opened. 3800 w. Gas Wld—Feb. 28, 1903. No. 54000 A.

Fischer System.

The Fischer Air-Gas System. Illustration, with description, of a plant for generating a gas by carburetting air with heavy tar oils—especially benzol—in a refined or unrefined state, claimed to be the cheapest illuminating medium known. 1800 w. Jour Gas Lgt—March 3, 1903. No. 54044 A.

Gas Coke.

The Coke Plant at the Smethwick Gas-Works. Illustrated description of a gravity bucket conveyor for feeding a water-gas plant. 4500 w. Jour Gas Lgt—March 3, 1903. No. 54043 A.

High Pressure.

Distributing Artificial Gas Under High Pressure. George F. Goodnow. Read before the Wisconsin Gas Assn. Notes relating to observations and experience during the past year, difficulties overcome, and methods used. 2200 w. Pro Age—March 16, 1903. No. 54070.

Recent Developments in High-Pressure Gas Lighting. Scott Snell. Report of a lecture before the Roval Scottish Soc. of Arts. Especially explaining the merits of the writer's system. 1600 w. Gas Wld—Feb. 28, 1903. No. 54001 A.

Meters.

Premature Corrosion of Wet Gas Meters. A. Albrecht, in *Journal für Gasbeleuchtung*. Summary. Considers the use of saline solutions in the meter, for sealing, for preventing freezing, or for thawing, to be the main cause, and suggests the remedy. 2000 w. Gas Wld—March 14, 1903. No. 54188 A.

Pipe Corrosion.

An Electrical Disturbance in the Gas Industry. D. D. Barnum. Read before the New England Assn. of Gas Engrs. An account of a leakage in a gas main, in Worcester, Mass., due to electrolysis. 1400 w. Am Gas Lgt Jour—March 23, 1903. No. 54317.

Smethwick.

Combined Oil-Carburetted and Blue Water-Gas Plant at Smethwick. Illustrates and describes the novel features of this recently installed plant. 2800 w. Jour Gas Lgt—March 10, 1903. No. 54177 A.

Street Lighting.

Street-Lighting. Tabulated reports by J. W. Bradley, of tests made of a great variety of systems and their cost, including both gas and electricity. 1700 w. Elec Engr, Lond—Feb. 20, 1903. No. 53868 A.

Tar.

Tar Fog. William Everitt. Read before the Manchester Dist. Inst. of Gas Engrs. A description of apparatus tried by the writer, with general discussion. 5500 w. Jour Gas Lgt—March 10, 1903. No. 54178 A.

INDUSTRIAL ECONOMY

Accounting.

Comparative Statements. Henry W. Brooks, Jr. On the importance of intelligent accounting, and the value of comparative statements showing the results of any change in policy or methods. Refers chiefly to street railway work. 2500 w. St Ry Rev—March 20, 1903. No. 54340 C.

The General Principles of Mine Accounting. E. Jacobs. A comparison of the engineering methods of mining with the corresponding business principles applicable to the recording and accounting work of the commercial side. 3000 w. Engineering Magazine—April, 1903. No. 54286 B.

Coal Strike.

The Anthracite Commission. Extracts from the report on the awards of the Commission, with editorial. 6000 w. Ir Age—March 26, 1903. No. 54335.

Copper Trade.

The World's Copper Trade. Horace J. Stevens. A review of the production and trade conditions for the year 1902 and prospects for 1903. 3300 w. Mines & Min—March, 1903. No. 53980 C.

Cost Keeping.

Cost Finding Methods for Moderate Sized Shops. Kenneth Falconer. A general account of the system used by the Canadian Composing Company, engaged in the manufacture of type composing machines; giving details and forms used. 2500 w. Engineering Magazine—April, 1903. No. 54288B.

We supply copies of these articles. See page 317.

Education.

Theory and Practice of Correspondence Schools. Frank McManamy. An explanation of the methods of instruction, especially in railway work. 2100 w. St. Louis Ry Club—Feb. 13, 1903. No. 53938.

Grain Traffic.

Great Lakes Grain Traffic. R. J. Donovan. An illustrated account briefly describing the elevator, the operations necessary in the handling of the grain, and the vessels engaged in the trade. 3000 w. Marine Engng—March, 1903. No. 53984 C.

Iron Trade.

The Export Trade of the German Iron Industry in 1902 (Der Aussenhandel der Deutschen Eisenindustrie in Jahre, 1902). Statistics, tables, and graphical diagrams, covering the past ten years. 1000 w. 3 plates. Stahl u Eisen—Feb. 15, 1903. No. 54245 D.

The Future of American Iron Costs. B. E. V. Luty. A study of the low prices of a few years ago, discussing how far they are likely to return. Also editorial. 4000 w. Ir & Coal Trds Rev—March 13, 1903. No. 54333 A.

Labor.

Issues Between Employers and Employees. Summary of actions taken by various organizations, including a new movement which has for its object the maintenance of the right of the individual to work when and under what terms he pleases. 3500 w. Ir Trd Rev—March 26, 1903. No. 54399.

Labor Crisis in the Scotch Shipbuilding Industry. A statement of the situation due to the wages controversy in the shipbuilding and engineering industries. 1800 w. Ir Age—March 12, 1903. No. 54022.

Labor Management.

The Working of a Labor Department in Factory Management. Charles U. Carpenter. A discussion of the importance of meeting labor questions at the earliest possible stage, and thus stopping troubles before they begin. 3500 w. Engineering Magazine—April, 1903. No. 54281 B.

Labor Organizations.

The Courts on Organized Labor. James A. Miller, Reprint from Volume II, No. 1, *Bulletin Corporations Auxiliary Company,* Cleveland, O. The article aims to encourage resort to the courts in labor troubles. Discusses the "right to parade," "picketing," the sympathetic strike, and injunctions. 6000 w. Ir Age—March 5, 1903. No. 53905.

The Rights and Methods of Labor Organizations. Albert S. Bolles. Discusses misconceptions that are somewhat general, explaining the attitude of many labor organizations, and the spirit of ill-will of employees toward employers, giving conclusions. 4500 w. N Am Rev—March, 1903. No. 53931 D.

Municipal Ownership.

Recent Attacks on Municipal Ownership in Great Britain. Robert Donald. Abstract of paper read at Nat. Con. on Munic. Ownership & Pub. Franchises. A review of municipal and engineering enterprise in England. 2000 w. St Ry Jour —March 7, 1903. No. 54067 D.

Municipal Trading.

European and American Methods and Results Compared. Robert P. Porter. Abstract of a paper at the Nat. Con. on Munic. Ownership & Pub. Franchises. Reviews the conditions briefly, but thinks a comparison hardly possible as the laws and needs so differ. 2800 w. St Ry Jour —March 7, 1903. No. 54068 D.

Profit Sharing.

The Steel Corporation Points the Way. Walter Wellman. An explanation and discussion of the wage earners' investment and profit-sharing plan, which was received with success. 6000 w. Rev of Revs—March, 1903. No. 53935 C.

Shipping.

The Present Position of British Shipping. Benedict W. Ginsburg. Discusses the rise and progress of British shipping with special reference to the Atlantic Shipping Trust and the effect of foreign subsidies. 4000 w. Page's Mag—March, 1903. Serial, 1st part. No. 54377 B.

Small Manufacturers.

The Problem of the Smaller Manufacturers of Rods and Merchant Bars. William Garrett. The writer's views on the prospects of getting raw material, and being able to compete with the United States Steel Corporation. Gives plans and discusses cost. 3800 w. Ir Trd Rev —March 5, 1903. No. 53959.

Unit Costs.

Recording Unit Costs of Contract Work. Emile Low. Considers the keeping of such accounts very desirable, and gives experience and methods used. 1500 w. Eng News—March 26, 1903. No. 54361.

Water Supply.

Duties of Municipalities Regarding Water Supply. Hon. J. O. Hall. Shows it to be the duty of the municipality to supply a generous amount of pure water for domestic uses, etc. 5600 w. Jour N Eng W-Wks Assn—March, 1903. No. 54385 F.

Workmen's Homes.

Working People's Homes. D. A. Tompkins. An explanation of the advantages of the building and loan system for the benefit of working people. 6200 w. Ill. Cassier's Mag—March, 1903. No. 54135 B.

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MARINE AND NAVAL ENGINEERING

British Navy.

Great Britain's Naval Supremacy. Archibald S. Hurd. Reviews the changed conditions which have required a change in policy and gives a table showing the forces ready for defence and the growth which has taken place. Ill. 4000 w. Cassier's Mag—March, 1903. No. 54134 B.

Cable-Ships.

The Cable-Ships "Restorer" and "Patrol." Illustrated descriptions of two recently completed vessels which represent the most modern practice, and possess interesting details due to their being intended for repairing rather than laying cables. 2500 w. Elect'n, Lond—Feb. 27, 1903. Serial. 1st part. No. 54007 A.

Cruiser.

Argentina Cruiser Moreno. Illustration and brief description of a vessel of the Garibaldi type, with comparison with other vessels of the size. 800 w. Engr, Lond—March 6, 1903. No. 54108 A.

Destroyer.

The Contract Speed Trial of U. S. Torpedo Boat Destroyer "Stewart." Albert Moritz. Illustration, description, and report of trial. 3500 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54170 H.

Dredges.

See Civil Engineering, Canals, Rivers, and Harbors.

Electricity.

Use of Electricity on German Vessels. Illustrations, with brief description of the uses to which electricity is applied on the "Kronprinz Wilhelm." 600 w. U S Cons Repts, No. 1587—March 6, 1903. No. 53907 D.

Fireboat.

New York Fireboat. Illustrated description of the fireboat designed by H. de B. Parsons, and its equipment. 1500 w. Marine Engng—March, 1903. No. 53985 C.

Fire Extinguishing.

Fire Extinguishing Apparatus for Ships. John H. Heck. Read before the N. E. Coast Inst. of Engrs. & Shipbuilders. Reviews various methods that have been tried, and describes briefly the Clayton fire extinguisher. Ill. 2000 w. Engrs' Gaz—March, 1903. No. 54042 A.

Floating Docks.

Floating Drydocks—Their Military Possibilities and Value. John D. Ford. An illustrated discussion of the construction, cost, advantages and value of drydocks, giving detailed description of the drydock at New Orleans. 5000 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54165 H.

The Evolution of the Floating Dock. An illustrated historical review. 2000 w. Engrs' Gaz—March, 1903. Serial. 1st part. No. 54041 A.

Labor.

See Industrial Economy.

Launches.

Steam Launches for the War Department. Illustrated detailed description of two 45-foot steam launches recently finished. 1800 w. Marine Engng—March, 1903. No. 53988 C.

Marine Boilers.

See Mechanical Engineering, Steam Engineering.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Monitor.

Contract Trial of the U. S. S. Wyoming. W. W. Bush. Illustration and description of the vessel with report of trial. 6000 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54169 H.

Oil Fuel.

See Mechanical Engineering, Steam Engineering.

Scotch Practice.

Some Useful Data from Scotch Marine Engineering Practice. H. Wilkes. Table and diagrams giving figures based upon engines, boilers and accessories actually constructed in Scotch shipyards. 600 w. Eng News—Feb. 26, 1903. No. 53851.

Shipping.

See Industrial Economy.

Small Boats.

The Powering and Propulsion of Small Boats. W. F. Durand. A general discussion of methods for determining the amount of power required for the propulsion of small boats at a desired speed. 3800 w. Marine Engng—March, 1903. No. 53986 C.

Steamships.

The Size of Steamships: Its Relation to Speed and Cargo-carrying Capabilities. Sidney Graves Koon. Discusses the characteristics of cargo steamers which might be designed for service between New York and London, describing a type-ship and

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discussing the economical performance. 2200 w. Sib Jour of Engng—Feb., 1903. No. 53936 C.

Submarines.

Official Trials of Submarine Boats Adder and Moccasin. William Russell White. Brief description with detailed report of trials and general comments upon the behavior and possibilities of the boats. Ill. 5200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54167 H.

Torpedoes.

The Modern Torpedo. Gustave Hubert. An illustrated detailed description of the Whitehead torpedo, with remarks on its value in warfare. 2700 w. Page's Mag—March, 1903. No. 54374 B.

U. S. Navy.

Our Actual Naval Strength. George W. Melville. Discusses the resources of the United States that strengthen the power of the navy, and shows the wisdom of providing for a strong and efficient navy. 6500 w. N Am Rev—March, 1903. No. 53930 D.

Yachts.

Shamrock III. A brief description of the latest yacht built for America cup racing. 1300 w. Sci Am—March 21, 1903. No. 54161.

MECHANICAL ENGINEERING

AUTOMOBILES.

Commercial Vehicles.

Commercial Self-Propelled Vehicles. Walter L. Bodman. An illustrated article considering the advantages of the motor wagon over horse-drawn vehicles with details of a proposed type of steam commercial vehicle. 1500 w. Automobile—March 7, 1903. No. 54018.

Cylinder Cooling.

Radiator Area per Horse Power in the Modern Gasoline Automobile. Herbert L. Towle. Gives results of a partial canvas of the more important machines at the Madison Sq. Garden show, showing the best machines have from 4 to 6 square feet of cooling surface per horse power. 2000 w. Automobile—Feb. 28, 1903. No. 53881.

Cylinder Jackets.

Experiments with Non-Freezing Liquids—A New Solution Proposed for Cylinder Jackets. E. Mallinckrodt, Jr. An account of experimental investigations made with a solution of calcium chloride under conditions similar to those obtaining in the circulation system of an automobile. 1500 w. Horseless Age—March 4, 1903. No. 53960.

Exhibits.

Technical Notes on Exhibits at Some Recent English Shows. J. S. V. Bickford. A summary of interesting points observed in late models of motor cycles and cars. Ill. 2800 w. Horseless Age—Feb. 25, 1903. No. 53841.

Gasoline Cars.

Data on Gasoline Touring Cars. J. G. Perrin. A comparison of data in the leading types exhibited at the recent exhibition in New York. 1200 w. Horseless Age—Jan. 28, 1903. No. 54040.

Ignition.

Constructing a Jump Spark Coil. George T. Hanchett. Discusses the troubles due to defective coils for ignition in explosion motors, and their remedy in the adoption of modern methods of construction. Ill. 4000 w. Automobile—March 14, 1903. No 54072.

The Eisemann System of Magneto Ignition. Illustrated description of a system of ignition in which the spark is produced by means of a high tension current, brought about by a rotary magneto machine working in conjunction with an induction coil without a trembler. 1600 w. Autocar—Feb. 21, 1903. No. 53870 A.

Kerosene Engine.

A Fuel Oil or Kerosene Engine. Marius C. Krarup. Problems in the construction of stationary and automobile motors studied in the Ostergren two-cycle engine, with liquid fuel injection, high compression and gradual combustion. Ill. 3500 w. Automobile—March 21, 1903. No. 54155.

Lamps.

Lamps for Fast Night Travel. Illustrated description of searchlights adapted to the needs of motorists. 1500 w. Automobile—Feb. 28, 1903. No. 53880.

Lubrication.

To Prevent Short Oil Pipes Robbing Long Ones. Thomas Clarkson. Extracts from a paper read at a meeting of the Automobile Club of Great Britain and Ireland. Gives statements of interest in regard to lubrication in automobiles. 900 w. Automobile—March 7, 1903. No. 54019.

Mail Van.

His Majesty's Mail by Motor Van. Gives a copy of the general report concerning the service of postal vans between Manchester and Liverpool, with illustrations and remarks. 2000 w. Auto Jour—March 7, 1903. No. 54098 A.

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Novelties.

Automobile Novelties (Les Nouveautés en Automobile). M. Miral. Describing details of machines shown at the Salon de l'Automobile of December, 1902, including an automobile fire engine, improved transmissions, etc. 2500 w. Revue Technique —Feb. 25, 1903. No. 54208 D.

Omnibus.

Electric Omnibuses for London. J. Sutherland Warner. Aiming to show how properly designed electric vehicles, operated systematically, could be made profitable; outlining the scheme. 2800 w. Elec Times —March 5, 1903. No. 54096 A.

Petrol Cars.

The Earl Petrol Car. Brief illustrated description of a 9 h. p. petrol vehicle, weighing about 15 cwt., with photographs of the chassis, showing the driving mechanism. 1500 w. Auto Jour—Feb. 21, 1903. No. 53871 A.

The Cottereau Petrol Vehicles. Illustrates and describes the interesting features of the various sizes made, with details of engines and carburetter. 1800 w. Auto Jour—March 7, 1903. No. 54097 A.

The Mandslay 1903 Petrol Car. Illustrated description of characteristic features of a heavy and powerful car, with photographs of the engines and gearing. 4000 w. Auto Jour—March 14, 1903. No. 54-185 A.

Reviews.

The Automobile Vehicle in 1902 (La Voiture Automobile en 1902). F. Drouin. An illustrated review of the exhibitions, trials, and constructive development of the automobile in 1902; with especial reference to French designs. Three articles. 8000 w. Génie Civil—Feb. 21, 28, March 6, 1902. No. 54203 each D.

Steam Cars.

A New Steam Motor Car. Illustrates and describes the Clarkson car. It is a substantial and roomy machine, in which paraffine oil can be used as a fuel. 1800 w. Engr, Lond—March 13, 1903. No. 54198 A.

The Latest Locomobile Steam Cars. Illustrates and describes a brougham, dos-a-dos, and surrey; also the shops of the company. 3200 w. Auto Jour—Feb. 28, 1902. No. 54002 A.

The Recent Development in Light Steam Cars. Filson Young. Some remarks on the development in steam cars and the latest types. 1700 w. Autocar—March 14, 1903. No. 54186 A.

Tools.

Automobile Machine Tools. George E. Walsh. Discusses the outlook for the automobile industry, the need of standardization and the design of special tools. 2000 w. Ir Age—March 12, 1903. No. 54023.

Trials.

Paris Fuel Consumption Trials Organized by "L'Auto." An account of this year's trials, with illustrations of the vehicles. 700 w. Auto Jour—Feb. 28, 1903. No. 54003 A.

Variable Speed.

Motor Driven Truck Having Novel Variable Speed Mechanism. Diagram and description of the construction of the variable-speed gear of a machine exhibited in the late automobile show, in New York. 1200 w. Mach, N Y—March, 1903. No. 53990.

The Simplex Gradual Variable-Speed Gear. Illustrated description of the mechanism invented by W. N. Dumaresq. 2500 w. Auto Jour—March 7, 1903. No. 54-099 A.

The Germain Electric Change-Speed Gear. Remarks on the various petrol-electric systems, and gives detailed illustrated description of the Germain system, pointing out some of the advantages of devices of this kind. 2000 w. Auto Jour—Feb. 21, 1903. No. 53872 A.

HYDRAULICS.

Bordeaux.

Extension of the Hydraulic Plant at the Port of Bordeaux (Agrandisement de l'Usine Hydraulique du Port de Bordeaux). A general account of the pumps, accumulators, and arrangement of the plant used to operate the hydraulic cranes at the port of Bordeaux, France. 3000 w. 1 plate. Génie Civil—Feb. 21, 1903. No. 54202 D.

Electric Pumping.

See Electrical Engineering, Power Applications.

Governor.

Hydraulic Regulator for Turbines (Hydro-Tachymètre pour Régulateur de Turbines Hydrauliques). L. Ribourt. A description of the writer's turbine governor, acting by variations in the pressure of a stream of water. 1200 w. Comptes Rendus—Feb. 23, 1903. No. 54213 D.

Hydraulic Cylinders.

The Strength and Proportion of Hydraulic Cylinders. Frank B. Kleinhans. Considers method of determining the thickness of the wall needed. Ill. 900 w. Am Mach—March 26, 1903. No. 54356.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Pumping Engine.

Old Pumping Engine at the New York Navy Yard Dry Dock. Illustrates and describes an engine of the double-acting beam

type, built when large engines were few, which has recently been replaced by two centrifugal pumps which drain the dock in half the time, and occupy about one-tenth the space. 1800 w. Power—March, 1903. No. 53882 C.

Pumping Plant.

A Riedler Pumping Plant for Hydraulic Mining in Alaska. An illustrated account of the Wild Goose Mining and Trading Co.'s plant at Nome. 1400 w. Eng & Min Jour—March 7, 1903. No. 54056.

Pumps.

Hydraulic Experiments on a Plunger Pump. Prof. John Goodman. Describes a series of experiments made on a small plunger pump, for the purpose of solving some of its mysterious actions, and gives results obtained. Ill. 8500 w. Inst of Mech Engrs —Feb. 20, 1903. No. 53927 D.

The Development of High-Pressure Centrifugal Pumps. John Richards. Explains the extensive use of these pumps on the Pacific Coast, their evolution and efficiency. Ill. 1200 w. Min & Sci Pr—Feb. 21, 1903. No. 53892.

Turbines.

Some Recent Water Turbine Plants. A. Steiger. Read at meeting of the Civ & Mech. Engrs. Soc. An illustrated paper on "Recent Turbine Plants in Great Britain and Abroad." Calls attention to the change in water power installations since the advent of electricity, and describes characteristic features of existing plants. 3000 w. Mech Engr—March 14, 1903. Serial. 1st part. No. 54184 A.

See also Electrical Engineering, Generating Stations.

MACHINE WORKS & FOUNDRIES.

Castings.

Casting Commutator Segments. C. Vickers. Directions and suggestions for securing the extreme accuracy required in such castings. Ill. 1800 w. Am Mach—March 5, 1903. No. 53973.

Cost Keeping.

See Industrial Economy.

Drilling.

Experiments upon the Work of Machine Tools—Drilling (Expériences sur le Travail des Machines-Outils—Forage). M. Codron. A study of the power required for various forms of drills, their efficiency and operation, forming a continuation of the author's investigations on machine tools. 12000 w. Bull Soc d'Encour—Jan. 31, 1903. No. 54253 G.

Multiple-Drilling Machines. Illustrations, with brief description of electrically driven machines for bridge work. 600 w. Engng—March 13, 1903. No. 54192 A.

Electric Driving.

See Electrical Engineering, Power Applications.

Files.

The Relative Economy of New and Re-Cut Files. Notes reproduced from a pamphlet issued by the Fairbanks Co., which seem to express the case very fairly. 1000 w. Mech Engr—53995 A.

Foundry.

The Future of the Foundry Industry. Dr. Richard Moldenke. A discussion of the outlook and the labor questions involved. 2800 w. Jour Am Found Assn—March, 1903. No. 53926.

Foundry Management.

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's fifth paper discusses especially the cupola, and the conditions involved in its successful and economical use. 4500 w. Engineering Magazine—April, 1903. No. 54285 B.

Gating.

The Gating of Castings. Benjamin D. Fuller. Read before the Pittsburg Foundrymen's Assn. Illustrated discussion of a number of examples and the methods employed. 2000 w. Foundry—March, 1903. No. 53944.

Grinding.

Cock Grinding Machine. W. E. Willis. Illustrates and describes a four-spindle cock grinding machine and its operation. 1000 w. Am Mach—March 26, 1903. No. 54355.

Index Grinding a Hard Steel Ratchet. Walter Gribben. Illustrates and describes the manner of doing the work. 1200 w. Am Mach—Feb. 26, 1903. No. 53847.

Labor Management.

See Industrial Economy.

Lathe.

Heavy Turret Lathe. Half-tones and line engravings of a new heavy turret lathe, with description of its interesting features. 2000 w. Am Mach—Feb. 26, 1903. No. 53846.

Machine Tools.

Constant Speed Belt-Drive for Machine Tools—Milling Machine Feeds. Herman Isler. An illustrated description of an arrangement of a constant speed belt drive with a table giving the different speeds obtained. 1200 w. Am Mach—March 19, 1903. No. 54144.

Medium and Light Machine Tools (Mittelgrosse und Leichtere Werkzeugmaschinen). H. Unger. An illustrated description of the light lathes, planers, shaping machines, etc., shown at the Düsseldorf exposition, 1902. Serial, Part I. 3000 w. Glasers Annalen—Feb. 15, 1903. No. 54223 D.

See also Mechanical Engineering, Automobiles.

Metal Cutting.

Metal Cutting with the New Tool Steels. Oberlin Smith. Discussing the influence of the introduction of high-speed tool steels upon machine tool design, involving the necessity of heavier construction and higher powering. 3000 w. Engineering Magazine—April, 1903. No. 54287 B.

Moulding.

Molding Air Chambers without Using Chaplets. J. Temple MacCartney. Illustrates and describes the method followed at the foundry of the Scranton Steam Pump Co. 1000 w. Foundry—March, 1903. No. 53945.

Planing.

Some Points About a Planer Shop. Discusses accurate planing, alignment of uprights, keeping planers leveled, gear testing, etc. Ill. 1800 w. Am Mach—March 5, 1903. No. 53972.

Railway Shops.

See Railway Engineering, Permanent Way and Buildings.

Riveting Machines.

Notes on the Design of Riveter Yokes. Chester B. Albree. Discusses the design of a pneumatic toggle joint riveter of 12-foot gap, made in one steel casting, of sufficient stiffness to drive rivets 1¾ inches in diameter. Ill. 2300 w. Pro Engrs of Soc of W Penn—Jan., 1903. No. 54154 D.

Steel Plant.

Steel Castings. George S. Willits. Describes an ideal plant, methods of manufacture, cleaning and testing, etc. 6200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54171 H.

Thermit.

The Thermit Process. Frank C. Perkins. Illustrates and describes the process of repairing castings and welding with thermit, giving an account of a recent demonstration in Brooklyn, and of marine repairs abroad, etc. 3500 w. Mach, N Y—March, 1903. No. 53989.

Works.

Queen's Engineering Works, Bedford. Detailed description, with illustrations of the works of W. H. Allen, Son & Co., builders of marine auxiliary machinery, and power-plant equipment. 2700 w. Engng—Feb. 27, 1903. Serial. 1st part. No. 54013 A.

The Laying Out of Engineers' Workshops. Joseph Horner. The first of a series of articles concerning the conditions which should govern the arrangements, dealing with extensions of old works, laying out of new, etc. 3000 w. Page's Mag—March, 1903. Serial. 1st part. No. 54376 B.

MATERIALS OF CONSTRUCTION.

Abrasives.

Crushed Steel and Steel Emery. M. M. Kann. An account of an artificial abrasive produced from steel, and the uses to which it is applied. 2000 w. Sci Am Sup—March 14, 1903. No. 54088.

Alloys.

Alloys as Revealed by Modern Research. Percy Longmuir. Discusses the tendency of present experiment and research and some of the causes affecting the properties. Ill. 3000 w. Feilden's Mag—March, 1903. No. 54371 B.

Alloys. Warner B. Bayley. Remarks on the increased consumption, improvement in manufacture, etc., with description of methods employed in their manufacture and in the making of tubing. 4200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54173 H.

Brass-Founding. A letter giving general information on alloys of copper. 1500 w. Am Mach—March 12, 1903. No. 54074.

Aluminum.

Aluminography. Translated from the German of Weilandt, in *Der Stein der Weisen*. Describes its use as a substitute for lithographic stone, and the production of printable designs. 5500 w. Sci Am Sup—March 7, 1903. No. 53969.

Working Aluminum. Joseph V. Woodworth. Suggestions for the proper working of this metal. Ill. 2200 w. Am Mach—March 26, 1903. No. 54354.

Brittleness.

See Mining and Metallurgy, Iron and Steel.

Lubricants.

Lubrication. William M. Davis. States the requirements of a good lubricant, and considers essential points in lubrication. 1500 w. Power—March, 1903. No. 53887 C.

Nickel Steel.

Temporary and Permanent Changes in Nickel Steels (Changements passagers et Permanents des Aciers au Nickel). C. E. Guillaume. A report upon the behaviour of bars of nickel steel under observation for six years, with respect to their suitability for standards of length. 1200 w. Comptes Rendus—Feb. 9, 1903. No. 54210 D.

White Iron.

Strength of White Iron Castings as Influenced by Heat Treatment. A. E. Outerbridge, Jr. Read at meeting of the Am. Soc. of the International Assn. for Test. Materials. Describes an unusual change observed in the chilled or white iron forming the "treads" of a number of wheels, and the cause; discusses the converting of white castings into "steel;" the differ-

ences found in white castings; and gives a resumé of experimental work in this field. 4000 w. Foundry—March, 1903. No. 53946.

MEASUREMENT.

Buckling.

The General Character of the Euler Law of Buckling (Die Verallgemeinerung der Eulerschen Knicklast). F. Wittenbauer. A mathematical examination of Euler's law for the buckling of columns, showing its generality. 2500 w. Zeitschr d Ver Deutschr Ing—Feb. 14, 1903. No. 54215 D.

Calorimetry.

Calorimetry of Gaseous and Liquid Fuels. W. Garnet Wernham. Extracts from a paper read before the Jr. Inst. of Engrs. Considers modern calorimeters, and methods of determining heating values of fuels. 3400 w. Jour Gas Lgt—March 3, 1903. No. 54046 A.

Dynamometer.

A Dynamometer Brake Permitting the Obtaining of a Constant Moment. Ed. Noaillon. Translated from *Bul. Sci. de l'Univ de Liége.* Presents an arrangement claiming that it permits a moment of resistance to act, which is strictly constant, whatever may be the variations in speed. Critical note by editor. 700 w. Sib Jour of Engng—March, 1903. No. 54152 C.

See Railway Engineering, Permanent Way.

Indicators.

Extended Applications for Indicators (Vorschläge über die Weitere Ausbildung von Indikatoren). A. Wagener. Discussing especially the use of the indicator with gas and other internal-combustion engines, and the special devices for such work. 3500 w. Zeitschr d Ver Deutscher Ing—March 7, 1903. No. 54218 D.

The Determination of the Scale of Indicator Springs (Beitrag zur Bestimmung der Massstäbe von Indikatorfedern). E. Förster. Illustrating and describing an apparatus for calibrating springs by steam and by direct loading. 2000 w. Zeitschr. d Ver Deutscher Ing—Feb. 28, 1903. No. 54217 D.

Oil Testing.

A New Oil Testing Apparatus (Ein Neuer Oelprüfapparat). G. Dettmar. A revolving spindle carrying sheaves is driven to a certain speed and released, and the time elapsing when it comes to rest is taken as a measure of the value of the lubricant. 1200 w. Glasers Annalen—March 1, 1903. No. 54225 D.

Metric System.

The Metric System. C. H. Tutton. Paper on the proposed measure to make the metric system the only legal standard of the United States, unfavorable to its adoption. General discussion. 5000 w. Jour Assn of Engng Socs—Feb., 1903. No. 54395 C.

Discussion on the Metric System. Abstract of notes by Alexander Siemens in opening the discussion, and Sir Frederick Bramwell's reply. Before the Inst. of Elec. Engrs. (England). 5000 w. Elect'n, Lond—Feb. 20, 1903. No. 53865 A.

Slide Rule.

The Execution of Computations with the Slide Rule (Berekeningen Uitvoerbaar met de Rekenlinaal). F. J. Vaes. Giving numerous examples of the ease and accuracy with which problems of actual importance may be solved by the slide rule. 3500 w. De Ingenieur—Feb. 14, 1903. No. 54267 D.

Speed Indicator.

See Electrical Engineering, Measurement.

POWER AND TRANSMISSION.

Compressed Air.

A Study in the Economical Arrangement of Compressed Air Haulage. Ernest Brackett. Considers the influence of haulage on the economical working limit and on the cross and haulage entry distances. 5600 w. Eng & Min Jour—Feb. 28, 1903. No. 53914.

High Speed Air Compressors (Ueber Kompressoren mit Erhöhten Umdrehzahlen). F. Harth. An examination of the action of air compressors operated at high rotative speeds, with especial reference to valve action and inertia forces. 3500 w. 1 plate. Glückauf—Feb. 14, 1903. No. 54230 D.

The Pneumatic Tube System of a Modern Department Store. Day Allen Willey. Illustrates and describes interesting features of this system. 2000 w. Sci Am—March 21, 1903. No. 54163.

Cone Pulleys.

A Method of Calculating the Range of Speed to be Obtained from a Pair of Equal Cones. Frank B. Kleinhans. Demonstration of the problem. 600 w. Eng News—March 26, 1903. No. 54360.

Laying Out Cone Pulleys. H. F. Moore. Describes method, giving diagrams and tests. 1200 w. Am Mach—Feb. 26, 1903. No. 53848.

Efficiency.

The Efficiency of Mechanism. C. F. Blake. The first of two articles dealing especially with hoisting machinery, discussing the general principles. 2400 w. Mach, N Y—March, 1903. Serial. 1st part. No. 53991.

Rope Splicing.

Transmission Rope Splicing. Frederick S. Greene. An illustrated description of

We supply copies of these articles. See page 317.

the English transmission splice. 1000 w. Power—March, 1903. No. 53885 C.

Worm Gearing.

Test of a Triple-Thread Worm Gear Transmission (Untersuchung eines Dreigängigen schneckengetriebes). C. Bach & E. Roser. Data and results of tests made at the Stuttgart Polytechnic, with especial reference to the lubrication and temperature. 4000 w. Zeitschr d Ver Deutscher Ing—Feb. 14, 1903. No. 54214 D.

The Construction of a Worm Profile (Konstruktion der Profillote einer Schnecke). H. von Glinski. A brief geometrical discussion of the problem. 1000 w. Zeitschr d Ver Deutscher Ing—March 7, 1903. No. 54219 D.

SPECIAL MOTORS.

Alcohol.

The Potato as a Source of Wealth in Germany. Information relating to the culture and uses, especially as a producer of alcohol. Describes the proposed exhibits at this year's exposition at Berlin, showing the manufacture and many uses of alcohol for technical and industrial purposes. Ill. 3000 w. U S Cons Repts, No. 1599—March 20, 1903. No. 54176 D.

Gas Engines.

A New Double-Acting Tandem Gas Engine. Illustration, with description, of a 1500 horse-power internal combustion engine developed by the Westinghouse Co. 700 w. R R Gaz—Feb. 27, 1903. No. 53859.

Central Station Gas Engines. C. H. Williams. Read before the Wisconsin Gas Assn. An account of the plant at Madison, Wis., where gas engines have been installed to furnish the motive power of a central station generating plant, with a general discussion of gas engines. 5000 w. Pro Age —Feb. 16, 1903. No. 54069.

Gas and Gasoline Engines. Edward Brenton Boggs. Describes these engines and their cycle of operations, testifying as to their economy and efficiency. 2500 w. Can Engr—March, 1903. No. 53982.

Gas-Engine Valve Gears. Charles Hurst. The discussion is confined to the mushroom type of valve, considering the sizes of the valves and area of passages, position, governing, etc. Ill. 4000 w. Feilden's Mag—March, 1903. No. 54372 B.

Recent Improvements in Gas Engines. Abstract of a paper by James Atkinson, read at meeting of the Manchester Assn. of Engrs. (England), and of the discussion. Calls attention to recent improvements and the rapid development of gas engines. 6000 w. Jour Gas Lgt—March 3, 1903. No. 54045 A.

The Economy of Small Gas Engines Using Montreal Illuminating Gas. Horner M. Jaquays. Information based on tests made under conditions as nearly similar to those which occur in practice as it is possible to make them. Ill. 3000 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54139 D.

The Letombe Mono-Triplex Gas Engine (Moteur Letombe Mono-Triplex). Illustrated description of the improved two-cycle gas engine of the Letombe pattern for use with furnace gas. 2000 w. Revue Industrielle—Feb. 21, 1903. No. 54276 D.

Gasoline Engines.

The Theory of Operation of the Gasoline Engine. E. C. Oliver. Explains the principles of operation of a two-cycle engine comparing the four-cycle engine, and reports a series of tests made. 4800 w. Jour Assn of Engng Socs—Feb., 1903. No. 54394 C.

See also Mechanical Engineering, Automobiles.

Gas Power.

The Gas Power Plant of the Embrach Potteries (Die Kraftgasanlage der Tonwarenfabrik Embrach). Describing a complete power plant with fuel gas generators, engines of 100 h. p. and electric generators in operation at Embrach, Switzerland. Two articles, 1 plate. 4000 w. Schweiz Bauzeitung—Feb. 28, March 7, 1903. No. 54229 each B.

STEAM ENGINEERING.

Blowing Engines.

The Compounding of Two Simple Blowing Engines. John H. Barr. An account of the scheme for converting two simple blowing engines of different make into a connected compound engine with duplex air cylinders. 1000 w. Sib Jour of Engng —March, 1903. No. 54150 C.

Boiler Coverings.

Tests of Various Methods of Covering Locomotive Boilers (Essais de Divers Modes d'Enveloppes de Chaudières de Locomotives). H. Ledoux. Data and results of tests made upon various laggings for locomotive boilers by the Paris, Lyons and Mediterranean Railway. 3000 w. Rev Gen des Chem de Fer—Feb., 1903. No. 54257 H.

Boiler Explosion.

The Bilston Boiler Explosion. An account of the explosion at the Bradley Bridge Iron Works, and the evidence brought out at the coroner's inquest. 3000 w. Engng—March 13, 1903. No. 54191 A.

Boiler Furnaces.

Corrugated Furnaces. W. C. Eaton. Description and report of tests made of

Brown's improved type. Ill. 3500 w. Jour Am Soc of Nav E ngrs—Feb., 1903. No. 54172 H.

Boiler House.

An Interesting Boiler House at Apponaug, R. I. Illustrated detailed description of the Dunnell boiler house, which serves a bleachery works. 1200 w. Eng Rec—March 7, 1903. No. 54050.

Boilers.

Actual Performance of Babcock and Wilcox Boilers as Installed in U. S. S. Marietta, with General Observations on Practical Requirements and the Successful Operation of Marine Water Tube Boilers. Henry C. Dinger. A detailed report of performance, advantages, defects, improvements, etc., with discussion of marine boiler design. Ill. 8400 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54168 H.

Boiler Construction. O. P. Hood. Digest of an address before the Copper Country Engng. Soc. on a neglected principle in boiler design. 1700 w. Aust Min Stand—Jan. 22, 1903. Serial. 1st part. No. 53996 B.

Iron Furnace Boilers. William H. Fowler. Illustrations, with brief descriptions of various types. 1200 w. Mech Engr—Feb. 28, 1903. No. 53994 A.

Multitubular Marine Boilers and Their Features. William H. Fowler. An illustrated description of the "Scotch" type, with discussion of its working. 1200 w. Mech Engr—March 14, 1903. No. 54183 A.

The Naval Boiler Problem. John Halligan, Jr. Discusses its importance in determining naval strength, its endurance under forced draft conditions, giving an illustrated description and an extended series of tests of the Hohenstein boiler. 6800 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54174 H.

Chimney.

High Concrete Chimney for the Pacific Electric Ry. Illustrated description of a chimney at Los Angeles, Cal., 180 ft. high, built of armored concrete. 1600 w. Ry & Engng Rev—March 14, 1903. No. 54117.

Condensers.

Central Condensation (Les Condensations Centrales). A. Abraham. A description of the advantages of central condensation and of the various forms of condensers in use in that connection. Serial. Part I. 1200 w. Revue Technique—Feb. 25, 1903. No. 54209 D.

Economy.

Economy in the Use of Coal for the Production of Power. Prof. Ira N. Hollis. Discusses this subject, showing what engineers are trying to accomplish, and the elements of efficiency. General discussion. 6000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54387 F.

Practical Economy in the Power Plant. W. H. Booth. Discussing the importance of taking all factors into account in the maintenance of economy in a power plant, instead of concentrating attention upon the more conspicuous portions. 2500 w. Eng Mag—April, 1903. No. 54282 B.

Engine Foundations.

Steam Engine Foundations. Some points on foundations of brick, stone, and concrete. Ill. 1500 w. Power—March, 1903. No. 53886 C.

Entropy.

Entropy. A review of the controversy of Swinburne v. Perry; Lodge intervening. 3000 w. Fielden's Mag—March, 1903. No. 54373 B.

Entropy. Prof. Robert H. Smith. An explanation of what is meant by the term, and of the causes that have led to misconception. 3200 w. Elec Rev, Lond—March 6, 1903. No. 54101 A.

Rankine's Thermodynamic Function and Entropy. Quotes from Rankine's works concerning the thermodynamic function and its use, and sums the various views upon entropy. 1400 w. Engr, Lond—Feb. 27, 1903. No. 54015 A.

Feed Water.

See Railway Engng., Motive Power.

Firebox.

See Railway Engng., Motive Power.

Mechanical Stokers.

Some Recent Tests of Mechanical Stokers. G. A. Hutchinson. A report of tests made on two representative types. 1200 w. Eng News—March 26, 1903. No. 54362.

The Evolution of the Mechanical Stoker. A. A. Cary. From a discussion at meeting of the New England Cotton Mfgrs. Assn. Gives illustrated description of methods of firing, and of various patents for improving the system, the furnaces, their operation, etc. 6000 w. Power—March, 1903. No. 53883 C.

Oil Fuel.

Liquid Fuel. H. F. Schmidt. A discussion of the advantages, apparatus used, cost, etc., showing that a special study must be made of each plant and the conditions under which it is to operate. 2500 w. Am Elect'n—March, 1903. No. 54030.

Liquid Fuel. W. D. Hoffman. An illustrated article discussing the advantages and obstacles to the use of liquid fuel for locomotive and marine boilers; the fire box, burners, etc. 8200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54175 H.

The Navy Experiments on Oil Fuel. Results and conclusions reached by the Bureau of Steam Engineering with illustrations. 2500 w. Locomotive—Jan., 1903. No. 54337.

We supply copies of these articles. See page 317.

Oiling System.

Oiling System for Power Plants. P. E. Moock. Read at meeting of the Ohio Soc. of Mech., Elec., and Steam Engrs. Considers the essentials of a good oiling system, giving suggestions. Ill. 1400 w. Engr, U S A—March 16, 1903. No. 54120.

Reducing Valve.

Royle's Reducing Valve. Illustrated description of a novel design of combined reducing valve and safety valve. 700 w. Mech Engr—Feb, 28, 1903. No. 53993 A.

Safety Valve.

Safety Valves. H. K. Spencer. Considers the method of determining the size of safety valve necessary for a given boiler. 1500 w. Marine Engng—March, 1903. No. 53987 C.

Steam Engines.

Tests of a Steam Engine. Abstract of a report by Prof. Schröter, of Munich, in regard to a series of interesting trials made by him on a Van den Kerchove engine exactly similar in construction to the one they exhibited at Paris, in 1900. 1200 w. Engr, Lond—Feb. 20. 1903. No. 53877 A.

The Investigation of the Stresses on Frames of Vertical, Inverted Steam Engines. G. Schwarz. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure*. Mathematical demonstration. 2200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54166 H.

The Construction of American Marine Engines (Die Konstruktion des Amerikanischen Schiffsmachinen). Walter Mentz. Notes of a journey of inspection, with illustrations of engines of American cruisers and other vessels. Serial. Par. 1. 3000 w. 3 plates. Schiffbau—March 8, 1903. No. 54265 D.

Steam Turbines.

Steam Turbines to Date. R. H. Thurston. Abstract of a lecture before the N. Y. Elec. Soc. Brief review of the history of the steam turbine, with remarks on the present status and the trend of progress. 1800 w. Ir Age—March 26, 1903. No. 54336.

The Steam Turbine in a Modest but Useful Aspect. J. E. Johnson, Jr. Illustrates and describes an installation for driving a forge for tool-sharpening. 1400 w. Am Mach—March 5, 1903. No. 53971.

Superheating.

The Use of Highly Superheated Steam. Prof. Ewing. A discussion of some points in regard to the advantages gained by superheating, referring to trials of an engine recently made by the writer. 2000 w. Engr, Lond—Feb. 20, 1903. No. 53876 A.

See Railway Engng., Motive Power.

Valve Gear.

Valve Gear of the Buckeye Engine. Illustrated detailed description. 1800 w. Power—March, 1903. No. 53884 C.

Waste Heat.

Waste Heat Engines. Prof. Edward F. Miller. Discusses recent attempts to increase the efficiency of an engine by reducing the temperature of the exhaust heat, describing the invention of Prof. E. Josse and the working of the engine. 2000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54388 F.

MISCELLANY.

Aeronautics.

Electricity as a Motive Power in Mechanical Flight. Dr. T. Byard Collins. Discusses progress in aerial navigation and the advantages and disadvantages of electricity as a motive power. Ill. 2500 w. Elec Wld & Engr—March 14, 1903. No. 54121.

Safety in Dirigible Balloons (La Securité dans les Ballons Dirigeables). Comm. P. Renard. An examination of recent disasters with dirigible balloons, showing their causes, and discussing necessary precautions. 6000 w. Bull Soc d'Encour—Feb. 28, 1903. No. 54255 G.

The Action of a Bird's Wing and Its Bearing on the Problem of Mechanical Flight. Dr. T. Byard Collins. An illustrated article describing methods of obtaining records of the action, and what they seem to indicate. 1800 w. Sci Am—March 7, 1903. No. 53967.

Air Resistance.

Experiments Upon Air Resistance (Expériences Relatives à la Résistance Opposée par l'Air). M. Barbel. The full report of the Committee of the Society for the Encouragement of National Industry upon the important experiments of Canovetti. 10,000 w. Bull Soc d'Encour—Feb. 28, 1903. No. 54254 G.

Explosives.

The Petavel-Kingsmill Recording Pressure Gauge. Illustrated description of an instrument for measuring the pressures produced by various explosives. 2700 w. Engng—March 13, 1903. No. 54194 A.

Heating.

Hot-Water Heating Systems (Die Einrichtungen zum Erwärmen von Wasser). Otto Marr. Describing various hot water systems, with formulas for use in computation of dimensions. 3000 w. Gesundheits-Ingenieur—Feb. 20, 1903. No. 54262 B.

Temperature Regulation. J. H. Kinealy. Read at meeting of Am. Soc. of Heat. & Ven. Engrs. A discussion of the systems and methods in use. 5500 w. Dom Engng—March 25, 1903. No. 54353 C.

We supply copies of these articles. See page 317.

Ventilation and Heating in the East High School, Rochester N. Y. Illustrated detailed description of arrangements for heating and ventilating a school-building having three stories and basement and attic. Mainly a plenum system. 4000 w. Eng Rec—Feb. 28, 1903. Serial. 1st part. No. 53904.

Ordnance.

The Hotchkiss Ordnance Company, Limited. Begins an illustrated description of recent types of rapid-fire machine guns made at these works near Paris. 4500 w. Engng—Feb. 20, 1903. Serial. 1st part. No. 53879 A.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Compressive Strength of Anthracite Coal. Tabulated results of investigations made by a committee of the Scranton Engrs. Club. 1500 w. Mines & Min—March, 1903. No. 53979 C.

Coal-Cutting.

Notes on Coal-Cutting by Machinery. Abstract of a paper by A. Dury Mitten, and the discussion. Shows that the conditions of the present make the subject an important one, and discusses briefly the advantages and difficulties. 2000 w. Col Guard—Feb. 20, 1903. No. 53875 A.

Coal Strike.

See Industrial Economy.

Coke.

The Demand for Coke. Frederick E. Saward. Gives facts in regard to the production and discusses its possible increase. 1300 w. Ir Age—March 12, 1903. No. 54021.

Coke Plant.

The New Coking Plant at the Theresa Mine in Polnisch-Ostrau (Die Neue Cokeanstalt am Theresienschachte in Polnisch-Ostrau). Dr. A. Fillunger. A description of important by-product coking works in Northern Austria. The gases are used for motive power. Two articles, 2 plates. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen —Feb. 28, March 7, 1903. No. 54233 each D.

Collieries.

The Mechanical Engineering of Modern Collieries. William Bardill. Abstract of a paper read before the Birmingham Sec. of the Inst. of Mech Engrs. Brief consideration of the mechanical appliances the mining engineer has found necessary in carrying on his work. 3000 w. Col Guard—March 20, 1903. No. 54401 A.

Germany.

The Costs and the Conditions of Working Collieries in Germany. The present article gives information concerning the Harpen collieries, their production, earnings, expenses, profits, etc. 1700 w. Ir & Coal Trds Rev—March 6, 1903. Serial. 1st part. No. 54109 A.

Lignite.

The Lignite Mines of North Dakota. Frank N. Wilder. Facts relating to output, the development of the lignite industry, mines and methods of mining. 2000 w. Eng & Min Jour—Feb. 28, 1903. No. 53912.

Mining Industry.

The Coal Mining Industry of the South. Frederick E. Saward. Reviews the rapid development of recent years in Alabama, West Virginia, Virginia, Kentucky, Tennessee, Indian Territory, Maryland and Texas. 2000 w. Ir Age—March 5, 1905. No. 53906.

Pennsylvania.

Lower Productive Coal Measures of the Bituminous Regions of Pennsylvania. Thomas K. Adams. Read before the W. Penn. Cent. Min. Inst. Describes the characteristic features of these deposits. 5800 w. Mines & Min—March, 1903. No. 53-976 C.

United Kingdom.

Rise and Progress of Coal-Mining in the United Kingdom. Prof. R. A. S. Redmayne. Notes of the first of a series of lectures delivered at the University of Birmingham. The present article reviews the early history. 2500 w. Col Guard—March 6, 1903. No. 54106 A.

Waste.

Squandering Coal. Egbert P. Watson. Remarks on the wastefulness so general in the United States, illustrating by actual occurrences, and urging greater economy. 1600 w. Ir Age—March 26, 1903. No. 54334.

COPPER.

Analysis.

The Estimation of Copper in Ores, Mattes, etc. O. H. Packer. Considers methods for the quantitative analysis of copper ores and products, especially commending and describing the aluminum strip, cyanide method. 2500 w. Elec Rev, N. Y.—March 14, 1903. No. 54077.

Arizona.

The Copper Deposits of Bisbee, Arizona. F. L. Ransome. A preliminary outline

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published by permission of the Director of the U. S. Geol. Survey. Considers the early history, geological features, character of ores, their origin, etc. Ill. 2200 w. Eng & Min Jour—March 21, 1903. No. 54330.

Blast Furnaces.

Width of Furnace Relative to Tonnage in Copper Matte Blast Furnace Practice. W. Randolph Van Liew. Reports results of a five days' trial and compares with other reports relating to furnaces of different widths, favoring the narrower furnace. 2200 w. Eng & Min Jour—March 21, 1903. No. 54329.

Copper Trade.

See Industrial Economy.

Michigan.

Copper Mining in Upper Michigan. J. F. Jackson. An illustrated description of the methods of opening and working the mines; with general discussion. 7000 w. Jour W Soc of Engrs—Feb., 1903. No. 54147 D.

Refining.

Progress in the Electrolytic Refining of Copper in 1902. Titus Ulke. A review, giving tables showing the electrolytic copper refineries operated during the year in the United States and in Europe. 2000 w. Eng & Min Jour—March 14, 1903. No. 54082.

GOLD AND SILVER.

Brazil.

The Gold Fields of Calcoeñe, Brazil. Maurice Cleré. Gives location, occurrence, deposits, etc. Ill. 1000 w. Eng & Min Jour—Feb. 28, 1903. No. 53913.

Cyaniding.

Cyanidation at the Homestake Mine. C. W. Merrill. Abstract of a paper read before the Black Hills Mining Men's Assn. Considers the nature of the ore, milling, classification, treatment, precipitation, etc. 3500 w. Eng & Min Jour—March 7, 1903. No. 54055.

Cyaniding Wet Crushed Ores. Hamilton Wingate. Describes experiments made with lime in the treatment of slimes, and the general treatment of refractory ores. 1400 w. Aust Min Stand—Feb. 12, 1903. Serial. 1st part. No. 54332 B.

East Indies.

Gold Mining in the Dutch East Indies. Map, with outline of the progress in mining. 2300 w. Eng & Min Jour—March 7, 1903. No. 54053.

Geological Survey.

West Coast of Cape York Peninsula, and Horn Island and Possession Island Goldfields. C. F. V. Jackson. Report of a visit, with twelve illustrations and maps. 11700 w. Queensland Gov Min Jour—Jan. 15, 1903. No. 53957 B.

Gold-Dredging.

The Development of Gold-Dredging in the United States. Ralph L. Montague, in London *Mining Journal*. Describes the type of dredge used, stating its advantages, and comparing with the New Zealand type; also gives brief history of the undertakings in the United States. 3000 w. Can Min Rev—Feb. 28, 1903. No. 53911 B.

Hydraulic Mining.

See Mechanical Engng., Hydraulics.

Mexico.

Minas Nuevas, Parral, Mexico. G. A. Burr and Louis S. Cates. Gives a plan showing the mines of the Veta Colorado, and begins a detailed report of their working and output. Mainly producers of silver. 2000 w. Eng & Min Jour—March 14, 1903. Serial. 1st part. No. 54081.

Nome.

Boring the Tundra of the Nome Gold Fields in Search of Gold. Otto Halla. Gives an account of investigations which have shown that the deposits between the hillsides and the Behring sea contain large amounts of auriferous gravel. 1000 w. Min Sci Pr—Feb. 28, 1903. No. 54025.

Ontario.

Notes on the Gold Ores of Western Ontario. Charles Brent. Describes the geology of these fields and the deposits, the interesting features, associated minerals, etc. 4000 w. Can Min Rev—Feb. 28, 1903. No. 53910 B.

Refining.

See Electrical Engineering, Electrochemistry.

Tailings.

Practical Application of Dr. Black's Permanganate Process. D. F. Meiklejohn. Illustrates the plant at Sierra City, Cal., and gives a report of a practical trial of the process and the results. 1600 w. Min & Sci Pr—Feb. 28, 1903. No. 54026.

IRON AND STEEL.

Bessemer Steel.

Bessemer Steel, Basic and Acid Process, with Analysis and Physical Tests. Robert H. Probert. Read at meeting of Ohio Soc. of Mech., Elec., and Steam Engrs. Discusses the manufacture of Bessemer steel. 4000 w. Engr, U S A—March 16, 1903. No. 54119.

Brittleness.

Experimental Studies of the Causes of Brittleness of Steel. Ch. Fremont. An illustrated description of experiments which show that both tension and compression tests are necessary and that flexure is a complete method of testing on condition that one gives to it the proper

sensitiveness. 2800 w. R R Gaz—March 13, 1903. No. 54131.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Ferromanganese.

A Study of Ferromanganese (Zur Kenntnis des Technischen Ferromangans). Th. Naske & A. Westermann. Discussing chemical analvses of commercial specimens of ferromanganese, showing the manner in which the constituents are combined. 3000 w. Stahl u Eisen—Feb. 15, 1903. No. 54-247 D.

Fuels.

The Use of High Sulphur Fuels in Blast Furnaces. Oskar Simmersbach, in *Stahl und Eisen.* Abstract translation showing the influence of sulphur on the various ores, and that high-sulphur fuel can be used under certain conditions. 1500 w. Ir Age—March 12, 1903. No. 54024.

Germany.

The Iron and Steel Industries of Germany in 1902. Herr Emile Schrodter. Report of general conditions, prices, exports, etc. 1300 w. Ir & Coal Trds Rev—Feb. 27, 1903. No. 54012 A.

The Present Condition of the Iron and Steel Industries of Westphalia (Etat Actuel des Industries du Fer et de l'Acier dans les Provinces du Rhin et de la Westphalia). A. Gowry. An exhaustive review of the metallurgical industries of Rhenish Prussia, with tables and numerous illustrations. 30,000 w. 5 plates. Mem Soc Ing Civ de France—Jan., 1903. No. 54264 G.

Iron Ore.

Applications of Magnetic Iron Ores Lean in Phosphorus (Verwendung von Phosphorarmen Magneteisensteinen). A discussion of the practicability of using the magnetites of northern Sweden in connection with hematite ores. 2000 w. Stahl u Eisen—Feb. 15, 1903. No. 54246 D.

Iron Trade.

See Industrial Economy.

Open Hearth.

Preliminary Refining in Connection with the Bertrand-Thiel and Thomas Processes (Ein Neues Vorfrischverfahren in seiner Anwendung auf den Bertrand-Thiel und Thomas Prozess). O. Thiel. Showing the advantages of the use of a preliminary furnace or converter in steel making. 2000 w. Stahl u Eisen—March 1, 1903. No. 54248 D.

Steel Plant.

The New Plant of the Jessop Steel Co. at Washington, Pa. H. G. Manning. Brief illustrated description of a plant consisting of a melting shop, rolling mill, power house and pickling shed. 1600 w. Eng News—Feb. 26, 1903. No. 53854.

See Mechanical Engineering, Machine Works and Foundries.

White Iron.

See Mechanical Engineering, Materials.

MINING.

Accounting.

See Industrial Economy.

Boring.

A Dutch Deep Boring Plant (Een Nederlandsche Diepboor Inrichting). C. J. Van-Loon. Illustratng and describing a well boring plant for explorations for coal and petroleum. 1800 w. De Ingenieur—Feb. 14, 1903. No. 54266 D.

Concentration.

The Concentration in Cornwall. C. M. Myrick. Illustrations, with outline of concentrating process used for the tin ores until a few years ago, when the more progressive mines introduced machinery. 1800 w. Min & Sci Pr—March 14, 1903. No. 54312.

Debris.

Impounding Mining Debris in Yuba River, California. Franklin Riffle. An account of the troubles arising from hydraulic mining and the dumping of tailings into the river, and the action taken by the Debris Commission for the storage of the detritus. 2300 w. Eng Rec—Feb. 28, 1903. No. 53903.

Drainage.

Mines Drainage in North Staffordshire. Richard H. Wynne. Notes on the Pottery Coal-field describing its geological and general construction, and some characteristics of its minerals, and methods used in freeing the mines of water. 1600 w. Ir & Coal Trds Rev—Feb. 27, 1903. No. 54011 A.

Electrical Prospecting.

The Daft and Williams System of Electrical Prospecting for Mineral Ores. Brief illustrated description of this system of locating bodies of metallic ore beneath the earth's surface. 900 w. Elec Engr, Lond—Feb. 20, 1903. No. 53867 A.

Electric Power.

See Electrical Engineering, Power Applications.

Electric Pumping.

See Electrical Engineering, Power Applications.

Fires.

Mine Fires. John Herman. Discusses the causes of fire and methods used in overcoming them. 1800 w. Min Rept—March 19, 1903. No. 54314.

Head Frames.

The Head Frames of Shafts at Cripple

Creek. Alexander Forsyth. A discussion of the problem of erecting frames for vertical shafts, stating the requirements and considering them seriatim. Ill. 2400 w. Eng & Min Jour—March 7, 1903. No. 54054.

Mine Disaster.

The Fraterville Mine Disaster. Official report of Hon. R. A. Shifflett, Commissioner of Labor, to the Governor of Tennessee, in regard to the accident. 5300 w. Mines & Min—March, 1903. No. 53978 C.

Mining Building.

The Hearst Memorial Mining Building, University of California. S. B. Christy. Description of this building for the University of California, for the instruction of students in mining and metallurgy. 1800 w. Eng & Min Jour—March 21, 1903. No. 54331.

Mother Lode.

Recent Mining and Milling Costs and Methods on the Northern Lode, California. Frank Langford. Describes methods of working and reports costs. 1500 w. Eng News—March 26, 1903. No. 54364.

Ore Deposits.

Secondary Enrichment of Ore Deposits. Prof. Arthur Lakes. Discusses the causes and effects of secondary deposits, with especial reference to the copper deposits at Cripple Creek and at Butte, giving briefly the conclusions of various authorities. 1200 w. Mines & Min—March, 1903. No. 53975 C.

The Ore Deposits of the Iglesias District, Sardinia. Abstract from a paper by Bergreferendar Duenkel, in *Zeitschrift f. d. Berg. Hutten u. Salinenwesen.* The deposits are chiefly argentiferous galena, but also blende and calamine. 1800 w. Eng & Min Jour—March 14, 1903. No. 54083.

Shaft Sinking.

Cost of Shaft-Sinking and Drifting at the Lincoln Gold Mine, California. Detailed statement of cost, taken from the report of E. C. Voorheis, with some additional facts. 800 w. Eng News—March 19, 1903. No. 54305.

Smelting.

Pyritic Smelting. Franklin R. Carpenter. Condensed from Bul. of Colorado Sch. of Mines. A discussion of the process or processes. 1200 w. Min & Sci Pr—March 14, 1903. Serial. 1st part. No. 54313.

Water Zone.

Water in Veins.—A Theory. T. A. Rickard. Based on information collected during the past two years concerning the manner of occurrence of water in veins. Believes in the existence of a distinct water zone. 3500 w. Eng & Min Jour—March 14, 1903. No. 54080.

MISCELLANY.

Mica.

The Crown Mica Mine, Custer City, South Dakota. Dennis Henault. Describes the peculiar occurrence at this mine, and the method of preparing for market. Ill. 1000 w. Min & Sci Pr—March 21, 1903. No. 54397.

Petroleum.

How Was Petroleum Made? J. Willway Treadwell, in the *Min. & Engng. Rev.* of San Francisco. A justification of the views of Alexander Humboldt against A. S. Cooper. 1500 w. N Z Mines Rec—Jan. 16, 1903. No. 53999 B.

Review.

Recent Progress in the Metallurgical Industries (Die Neuestern Fortschritte auf dem Gebiete der Metallurgie). Dr. Carl Schnabel. A general review of developments in the metallurgy of gold, silver, copper, lead, zinc, and nickel during 1902. 3500 w. Glückauf—Feb. 28, 1903. No. 54231 D.

Tin.

The Greenbushes Tinfield, W. A. C. A. Mulholland. Begins a description of an interesting field from a scientific point of view, from the variety of the deposits and the metallurgical problems to be solved. 1200 w. Aust Min Stand—Jan. 29, 1903. Serial. 1st part. No. 53997 B.

Zinc Oxide.

Ellershausen and Western's Zinc White Process. Edward Walker. Information of a new process of making zinc oxide direct from blende. 900 w. Eng & Min Jour—March 14, 1903. No. 54079.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in January. Condensed record with editorial review of the more serious accidents. 5300 w. R R Gaz—Feb. 27, 1903. No. 53860.

Passenger Service.

Express Passenger Travelling in the Future. H. C. Fyfe. An illustrated discussion of the monorail (Behr) system, and of the suspended railway system as solutions of the problem of conveying passengers at high speed. 4800 w. Page's Mag—March, 1903. No. 54375 B.

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Pooling.

Pooling Engines. J. V. N. Cheney. A statement of some of the trials and troubles due to the pooling of engines. 2400 w. R R Gaz—March 6, 1903. No. 54038.

Train Indicator.

An Electric Train Indicator. E. C. Parham. Describes a device whereby passengers at stations may tell the destination of any approaching train. 1200 w. Am Elect'n—March, 1903. No. 54033.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Hill's Either-Side Brake. Illustrates and describes an improvement effected in the working parts of this brake, and also illustrates the Platt brake, the owners having brought suit for infringement. 800 w. Col Guard—Feb. 20, 1903. No. 53873 A.

The Structure and Service of Modern Brakeshoes. F. W. Sargent. Read before the New England Air Brake Club. Considers the action of brake shoes, the effect of heat generated, the various types in general use, wear, etc. 4200 w. Ry Age—Feb. 27, 1903. No. 53890.

Cars.

Large Capacity Gondola Cars; Chicago & Alton Ry. Brief illustrated description. 500 w. Eng News—Feb. 26, 1903. No. 53856.

Pratt Side Dumping Coal Car. Drawings and description of a 60,000-lb. car. 500 w. R R Gaz—Feb. 27, 1903. No. 53858.

Feed Water.

The Chicago & North-Western Railway Company's Method of Purifying Water for Locomotive Boilers. G. M. Davidson. On the treatment to remove scale-forming matter, showing that it can be easily and economically accomplished. Illustrated description of apparatus used, and report of cost, etc. Also discussion. 18500 w. Pro W Ry Club—Feb. 17, 1903. No. 54138 C.

The Purification of Feed Water. J. B. Greer. Read before the Ry Club of Pittsburg. A review of what has been accomplished in the purification of water for boiler use. 2000 w. Ry & Engng Rev—Feb. 28, 1903. No. 53894.

Firebox.

A Water Arch for Locomotive Fireboxes; Montana Central Ry. Illustrated description of the application of water arch to a wide fire box locomotive of the Great Northern Ry., invented by A. E. Taber. Gives results of experience with its use. 700 w. Eng News—March 19, 1903. No. 54310.

Locomotives.

A Proposed Single Driver Locomotive. Paul T. Warner. Gives diagram showing the principal features of a single driver locomotive with single cylinders, designed for burning bituminous coal and capable of hauling 250 tons exclusive of its own weight, at 60 miles an hour. Discusses its efficiency. 900 w. R R Gaz—Feb. 27, 1903. No. 53861.

"Belpaire" Express Locomotive, Midland Railway. Illustrations, with brief description of recently built engines. 600 w. Engr, Lond—March 13, 1903. No. 54197 A.

Compound Coupled Locomotive for the Mediterranean System (Locomotiva Compound a 4 Assi Accoppiati e Carello della Rete Mediterranea). Illustrated description of 70 ton freight engine of which type 30 are under construction for the Mediterranean railway system of Italy. 1200 w. Rivista delle Strade Ferrate—Feb. 15, 1903. No. 54275 D.

English and German Tank Locomotives. Frank C. Perkins. Illustrated descriptions of a British "Saddle Tank" engine, and a similar side tank engine of the "Bengal" class, and of a four-wheel connected tender locomotive of German build. 700 w. Sci Am Sup—Feb. 28, 1903. No. 53844.

Express Passenger Engine. Illustrated detailed description of a powerful type of locomotive for handling very heavy traffic on the London, Chatham, & Southeastern Ry., which abounds in steep inclines and sharp curves. 800 w. Engr, Lond—Feb. 27, 1903. No. 54016 A.

Freight Locomotives. Drawings, photograph and general description of engines of the 2-8-0 type being built for the C., R. I., & P. Ry. 600 w. Am Engr & R R Jour—March, 1903. No. 53925 C.

German Freight and Switching Locomotives. Illustrations, with brief description of two types of freight locomotives and a switching engine, all of recent construction. 700 w. Ry & Engng Rev—Feb. 28, 1903. No. 53895.

Heavy Freight Locomotives for the Chicago, Burlington & Quincy System. Illustrated description of a consolidation freight engine which represents the heaviest class yet built for this line. 1600 w. Ry & Engng Rev—Feb. 28, 1903. No. 53893.

Locomotives and Cars for Express Service (Lokomotiven und Wagen für Schnellverkehr). An examination of the designs awarded prizes at the recent competition of the Verein Deutscher Maschinen Ingenieure. 2500 w. 6 plates. Glasers Annalen—March 1, 1903. No. 54227 D.

Pacific Type Locomotive for Northern Pacific. Illustration, elevations and plan of an engine for heavy fast passenger service in mountain districts, with description. 500 w. Ry Age—Feb. 27, 1903. No. 53889.

Powerful Passenger Locomotive. Illus-

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trated detailed description of engines of the 4-6-2 type, intended for very heavy and comparatively slow passenger excursion trains. 600 w. Am Engr & R R Jour—March, 1903. No. 53921 C.

Six-Coupled Locomotive for Fast Goods Traffic; Great Central Railway. Illustration of a six-wheeled coupled bogie mixed train engine and tender recently constructed for fast goods and fish trains on this road. Leading particulars are given. 500 w. Engng—March 20, 1903. No. 54402 A.

Some Abnormal British Locomotive Types. Charles Rous-Marten. An illustrated article describing peculiar types that have appeared on British railways. 6300 w. Cassier's Mag—March, 1903. No. 54136 B.

Steam Distribution in Compound Locomotives (Les Distributions des Locomotives Compound). R. Godfernaux. Discussing especially the Gölsdorf and the Henschel valve gears for compound locomotives. 2000 w. Rev Gen des Chem de Fer—March, 1903. No. 54261 H.

Ten-Wheeled Engine for the Rutland. Illustration, with brief description. 300 w. Loc Engng—March, 1903. No. 53919 C.

Test of Oil Burning Locomotive. Report of a running test, with full tonnage, made on the A. T. & S. F. Ry. for a distance of 1,422 miles. 600 w. Am Engr & R R Jour—March, 1903. No. 53924 C.

Lubrication.

Simple vs. Compound Lubrication. C. B. Sopper. A comparison of the amount of lubricant required for simple and compound locomotives. 1600 w. Loc Engng—March, 1903. No. 53918 C.

Speed Indicator.

See Electrical Engineering, Measurement.

Superheating.

Locomotive for Superheated Steam (Heissdampflokomotive). J. Obergethmann. An illustrated description of the Schmidt locomotive, exhibited at Düsseldorf and built for the Prussian State Railways. Serial. Part I. 2500 w. 1 plate. Zeitschr Ver Deutscher Ing—Feb. 28, 1903. No. 54216 D.

See Mechanical Engineering, Steam Engineering.

Tank Car.

The Van Dyke Tank Car. Illustrates and describes a new tank car of simple design, calling attention to novel features. 800 w. R R Gaz—March 6, 1903. No. 54037.

Train Lighting.

Electric Lighting of Trains. An illustrated description of the Kull system. 1300 w. Aust Min Stand—Jan. 29, 1903. Serial. 1st part. No. 53998 B.

Electric Train Lighting (Elektrische Zugsbeleuchtung). Reviewing the methods using a dynamo driven from the car axle, with especial reference to the Stone system. 1800 w. Schweizerische Bauzeitung—Feb. 21, 1903. No. 54228 B.

The Adlake Acetylene Car Lighting System. Louis K. Gillson. Read before the New England Ry. Club. A description of this system, claiming efficiency, economy, reliability, and safety. 4000 w. Ry & Engng Rev—Feb. 28, 1903. No. 53896.

Wheel Loads.

See Civil Engineering, Bridges.

NEW PROJECTS.

Cuba.

Opening of New Railroad in Cuba. J. W. Davies. An illustrated historical account of the road connecting Santa Clara with Santiago de Cuba, thus opening the whole island, and conferring great benefits. 1700 w. Gunton's Mag—March, 1903. No. 53932.

Pennsylvania R. R.

Improvements on the Pennsylvania Railroad. S. Whinery. An outline of some of the more important improvements in progress, as well as those recently completed and projected. Ill. 4800 w. R R Gaz—March 13, 1903. Serial. 1st part. No. 54126.

Railroad Development.

The Kansas City, Mexico & Orient Railway Enterprise. Map and description of new line that will connect at Port Stilwell with steamships for the Orient. 3800 w. Ry Age—March 20, 1903. No. 54346.

PERMANENT WAY AND BUILDINGS.

Accounting.

Classification of Maintenance-of-Way Expenses. Walter G. Berg. Read at convention of Am. Ry. Engng. & Maintenance of Way Assn. On the distribution of railroad expenses, outlining a proposed system for keeping accounts. 16700 w. Ry Age—March 20, 1903. No. 54352.

Automatic Stops.

An Expert's Experience with Automatic Stops. W. H. Elliott. A discussion of the inherent difficulties in the working of the automatic stop that make its use objectionable. 3500 w. R R Gaz—March 6, 1903. No. 54036.

Construction.

Engineering and Construction of the St. Louis, Kansas City & Colorado Railroad. Inset and illustrations with description and general information, specifica-

tions, etc. 6800 w. Ry Age—March 20, 1903. No. 54343.

Culverts.

Methods of Surfacing Concrete Culverts. George W. Lee. Illustrates and describes the new culverts on the Pennsylvania Division of the New York Central R. R., and the methods of construction. 700 w. Eng News—March 19, 1903. No. 54304.

Curves.

Method of Computation by the Addition of Ordinates (Procédé de Calcul par Addition d'Ordonnées). Pierre le Fort. Describing a method of equalizing railway curves permitting a continuous variation in the radius of curvature in all cases. 12000 w. Rev Gen des Chem de Fer—March, 1903. No. 54260 H.

Spiral Curves for Railways (Cur les Raccordements à Courbure Progressive pour Voies Ferrées). M. d'Ocagne. A discussion of the clothoide curve, with tables for its application to railways. 4500 w. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54251 E+F.

Dynamometer.

Dynamometer Car of the Orleans Railway (Wagon Dynamometre de la Compagnie d'Orleans). M. Huet. Illustrated description of dynamometer car containing improved recording devices constructed by Amsler, of Schaffhausen. 3500 w. 3 plates. Rev Gen des Chem de Fer—March, 1903. No. 54259 H.

Electrical Equipment.

See Electrical Engineering, Power Applications.

Rails.

The Rail as a Girder. Dr. P. H. Dudley. Gives evidence from experience demonstrating the value of stiffness in a rail as a girder and discussing the subject generally. 3500 w. R R Gaz—March 13, 1903. No. 54133.

Relocation.

Relocation of the Chicago, Burlington & Quincy in Western Iowa. An illustrated article, showing changes made to eliminate short radius curves and steep grades. 1300 w. Ry Age—March 20, 1903. No. 54348.

Roadway.

Specification for the Formation of a Roadway. Part of the committee report on roadway at the convention of the Am. Ry. Engng. & Maintenance of Way Assn. 7500 w. Ry & Engng Rev—March 21, 1903. No. 54321.

Shops.

Extensive Shop Improvements. Plans, illustrations and description of the important features in the extensive improvements under way at Jackson, Mich., for the shops of the Michigan Central Railroad. 3000 w. Am Engr & R R Jour—March, 1903. No. 53922 C.

Railroad Shops. Walter G. Berg. The first of a series of articles discussing carefully the shop question and its relation to the other departments. Ill. 3000 w. R R Gaz—March 13, 1903. Serial. 1st part. No. 54127.

The Reading Locomotive Shops. An illustrated detailed description of one of the most extensive locomotive repair shops in the United States, and the equipment. 4500 w. Ry Age—March 6, 1903. No. 54027.

Signals.

Block Signals on American Railroads. Gives tabulated statement of the miles worked by the block system on each road using it, with notes on proposed new signalling. 2000 w. R R Gaz—Feb. 27, 1903. No. 53857.

Electric Interlocking at the Lake Shore-Rock Island Terminal. Diagram of the yard at Chicago, with brief description. 500 w. R R Gaz—March 13, 1903. No. 54125.

Signalling and Interlocking. Report, with colored inset, presented at convention of the Am. Ry. Engng. & Maintenance of Way Assn. Also discussion. 20,000 w. Ry Age—March 20, 1903. No. 54351.

Train Order Signals. Part of the report of the committee on signaling and interlocking presented at the convention of the Am. Ry. Engng. & Maintenance of Way Assn. 1200 w. Ry & Engng Rev—March 21, 1903. No. 54320.

Station.

The New Rock Island-Lake Shore Passenger Station at Chicago. Illustrated description of a combined office building and station, which is of interest because of the dispatch with which the work has been carried on. 2000 w. Ry Age—March 20, 1903. No. 54344.

Terminal Improvements.

The St. Louis Terminal Improvements. Inset, with description of the rearrangement to enlarge the capacity and improve the facilities. Some interesting engineering problems involved. 3400 w. R R Gaz—March 20, 1903. No. 54318.

Ties.

Ties. From a report of the committee on ties to Am. Ry. Engng. & Maintenance of Way Assn. 2500 w. Ry & Engng Rev—March 21, 1903. No. 54322.

Tracks.

The Effect on Track of Modern Equipment and High Speed. P. H. Dudley. A discussion of the distribution of loads, and of stresses, and of various things bearing

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on the wearing of tracks. Considers the statements of Mr. Hugh Wilson. 2800 w. Ry Age—March 20, 1903. No. 54342.

Tunnels.

See Civil Engineering, Construction.

Water Supply.

Chicago & Alton Water Supply. An illustrated description of the system of reservoirs, with information relating to them. 1500 w. Ry Age—March 20, 1903. No. 54347.

Yards.

A New Yard Design. W. C. Cushing. Gives a plan of a gravity freight yard for a large traffic, designed by the writer, with remarks on defects observed in the committee design. 1800 w. R R Gaz—March 13, 1903. No. 54132.

TRAFFIC.

Freight.

The Most Advantageous Loads and Speeds for Merchandise Trains (Les Charges et les Vitesses le Plus Favorables des Trains de Marchandises). F. Barbier. Deducing formulas in which to introduce the operative conditions and determine the best train mileage. 1800 w. Génie Civil—Feb. 14, 1903. No. 54201 D.

Report.

Colonel Yorke's Report on American Railroads. Extracts from the report of Col. H. A. Yorke to the British Board of Trade. 2000 w. R R Gaz—March 20, 1903. No. 54319.

American and British Railway Methods. Editorial review of Col. Yorke's report to the British Board of Trade on a visit to the United States made with a view to investigate railway methods. The present article deals with steam railway practice only. 3000 w. Mech Engr—March 14, 1903. No. 54182 A.

Traffic Problems in England and America. R. H. Scotter. An analysis of Col. Yorke's report to the British Board of Trade upon his recent visit to America. 3000 w. Elec Times—March 12, 1903. No. 54181 A.

The Pennsylvania Annual Report. A report of operation for 1902; improvements made and expenditures; and improvements planned; with much information of interest. Also editorial. 6700 w. R R Gaz—March 6, 1903. No. 54039.

Time Element.

The Influence of Time Element on Mechanical and Transportation Matters. H. T. Herr. Discusses the proper basis for traffic statistics, with the view of drawing out opinions of others, and securing economy and efficiency. 1400 w. Am Engr & R R Jour—March, 1903. No. 53920 C.

Train Speed.

The Efficient Speed of Freight Trains (De Gunstige Snelheid van Goederen Treinen). F. J. Vaes. With tables and curves showing the relation between cost and speed in merchandise transport. 3500 w. De Ingenieure—March 7, 1903. No. 54269 D.

MISCELLANY.

Missouri.

Early History of Railroads in Missouri. W. J. Thornton. A general review of railroad development in the United States, and detailed history of the roads in the state named. 6800 w. St. Louis Ry Club —Feb. 13, 1903. No. 53937.

Railway Practice.

Diversity of Practice in General Engineering on American Railways. Archibald A. Schenck. Notes some points of difference in engineering practice on American railways. Deals chiefly with methods of work, showing the leading aim on various roads. General discussion follows. 31000 w. Jour W Soc of Engrs—Feb., 1903. No. 54148 D.

Taxation.

The Wisconsin Railway Taxation Bill. Gives extracts from the briefs presented by the C. M. & St. P. and the C. & N. W. Rys. in reply to the recommendations on railway taxation in Gov. La Follette's annual message. 11600 w. Ry Age—March 13, 1903. No. 54112.

STREET AND ELECTRIC RAILWAYS

Car Houses.

Car House Construction. Discusses design and construction, the need of getting as nearly complete fireproofing as possible, giving examples illustrating points discussed. Ill. 3500 w. St Ry Jour—March 14, 1903. No. 54114 D.

Cars.

New York Subway Cars. Gives plans and general description of the standard construction determined upon, 500 cars now being built. 1000 w. Am Engr & R R Jour—March, 1902. No. 53923 C.

Car Works.

The British Electric Car Company. Illustrated description of the factory and its equipment, and the electric cars built. 2300 w. Engng—Feb. 20, 1903. No. 53878 A.

Chicago.

Modern Shops and Methods of the Chi-

We supply copies of these articles. See page 317.

cago City Railway Company. Illustrates and describes shops representing the most modern ideas as to construction and equipment. 3500 w. St Ry Jour—March 7, 1903. No. 54064 D.

Electric Locomotives.

Accumulator Locomotives on Two Lines of the Italian Central Railway in Emilia, Italy. Enrico Bignami. An illustrated account of tests with accumulator traction on the Bologna-San Felice line and the Bologna-Modena. 3000 w. Elec Rev, N Y—Feb. 28, 1903. No. 53897.

Electric Locomotives for Yard and Shop Work. Classifies industrial electric locomotives, and considers some of their important uses. Ill. 1000 w. Sci Am—March 7, 1903. No. 53968.

The Electric Locomotives on the Western Railway of France. Views and particulars of machines possessing very novel features, in use on the Versailles division. 1100 w. St Ry Jour—Feb. 28, 1903. No. 53915 D.

Elevated Structure.

Elevated Structure of the New York Rapid Transit Railroad. Illustrates and describes interesting details of this viaduct. 1100 w. Eng Rec—Feb. 28, 1903. No. 53900.

Engines.

The Choice of Engines for Traction Stations. E. Kilburn Scott. Considers the importance of simplicity of design, and states the advantages of the ordinary tandem—compound single-crank engine and the employment of high superheat. 800 w. Elec Rev, Lond—Feb. 27, 1903. No. 54006 A.

Europe.

Electric Railway Practice on the Continent of Europe. Heinrich Vellguth. An illustrated account of the most interesting developments in electric railway practice in Austria, Hungary and Italy. 3000 w. St Ry Jour—March 7, 1903. No. 54062 D.

Grades.

Units for Indicating Grades. Carl Hering. Refers to sources of confusion, and gives a conversion table for grades. 1000 w. St Ry Jour—March 7, 1903. No. 54063 D.

Guard Wires.

Board of Trade Guard Wire Regulations for Electric Tramways. A copy of the new regulation to be required in all new undertakings in England. 1600 w. Elect'n, Lond—Feb. 20, 1903. No. 53864 A.

Interurban.

A Decade of Interurban Electric Railways. Louis Bell. Reviews the electric interurban development, and discusses their future and the field they must occupy. 2000 w. St Ry Jour—Feb. 28, 1903. No. 53917 D.

Electric Railway Bridges. Wilbur J. Watson. Remarks on the tendency of electric railways to approach steam railway conditions of loading and the effect of the many cars now operated upon existing bridges, discussing design, factor of safety, etc. 4000 w. Jour Assn of Engng Socs—Jan., 1903. No. 54158 C.

Engineering Preliminaries for an Interurban Electric Railway. Ernest Gonzenbach. Gives plans and recommendations embodied in a report on a proposed railway, showing the way in which certain conditions were met, with reasons. 3500 w. St Ry Jour—March 7, 1903. Serial. 1st part. No. 54065 D.

Northern Ohio Interurban Lines. An illustrated description of the Columbus, Delaware & Marion Ry., which is a part of an electric system which will eventually reach Cleveland. 4500 w. St Ry Jour—March 21, 1903. No. 54323 D.

Protected Third-Rail Interurban Road in Pennsylvania. An illustrated detailed account of the Wilkesbarre & Hazleton railroad in the anthracite coal regions, which is intended to compete with steam roads for freight as well as passenger business. 600 w. St Ry Jour—March 7, 1903. No. 54061 D.

Some Notes Respecting the Legal Status of Electric Interurban Railways. Gives information in regard to the legal status of electric railways in Indiana, Illinois, Ohio, Michigan, New York, Connecticut, and Massachusetts. 2800 w. Eng News—March 5, 1903. No. 54035.

The Performance of the Dayton & Troy Electric Railway Power House. An account of the performance of a direct-current power house supplying boosters for feeding the distant portions of the line, describing the equipment, character of the road, tests made, etc. Ill. 3800 w. St Ry Jour—Feb. 28, 1903. No. 53916 D.

The Providence & Danielson Ry. Illustrated account of this road which forms the completing line in a system of electric lines from Worcester, Mass., to Providence, R. I. It is for passengers and freight, and has an interesting adaptation of storage batteries. 2400 w. St Ry Rev—March 20, 1903. No. 54341 C.

Urban and Interurban Locomotion in America. Robert P. Porter. Reviews the report of Lieut.-Col. H. A. Yorke and discusses the projected extensions in Greater New York, in the present article. 3000 w. Engng—March 13, 1903. Serial. 1st part. No. 54193 A.

Italy.

The Status of the Electric Traction Problem in Italy (I Termini del Problema

We supply copies of these articles. See page 317.

della Ferrovia Elettrica Italiana). P. Lanino. A discussion of the relation of electric traction to the railways of Italy, urging the standardisation of apparatus and methods. 3000 w. L'Elettricità—March 8, 1903. No. 54244 D.

Johannesburg.

The Johannesburg Electrical Scheme. Notes indicating the character of the proposals and the different items of expenditure relating to a scheme for furnishing electric light, power, and tramways. 3000 w. Elec Rev, Lond—Feb. 20, 1903. No. 53869 A.

Massachusetts.

The Experience of Massachusetts in Street Railways. Louis D. Brandeis. Read at Nat. Con. on Munic. Ownership & Pub. Franchises. An account of the development of street railway lines. 3500 w. St Ry Jour—March 7, 1903. No. 54066 D.

N. Y. Subway.

A Complete Rapid Transit System for New York. Extracts from the report of William Barclay Parsons for the boroughs of Manhattan and the Bronx, with brief comments. Map. 1000 w. Ry Age—Feb. 27, 1903. No. 53888.

The Proposed Extensions of the New York Rapid Transit Railway System. Extracts from the report of Mr. William Barclay Parsons, explaining the work and giving reasons for the suggested improvements. 1200 w. Eng News—Feb. 26, 1903. No. 53853.

The Type of Controllers and Motors to be Used in the New York Subway. Illustrated description of the controller equipments and of the General Electric motors. 2500 w. St Ry Jour—March 14, 1903. No. 54115 D.

Westinghouse Motors for the Rapid Transit Subway, New York. Illustrated description of motors designed especially for this purpose, to fit the conditions and requirements. 1500 w. St Ry Jour—March 21, 1903. No. 54324 D.

Poles.

Side Poles for Electric Tramways. George G. Braid. Gives calculations relating to the strength and stiffness of side poles used for supporting the overhead construction work of electric railways. Mathematical. 1800 w. Elec Engr, Lond—Feb. 27, 1903. No. 54004 A.

Safety Devices.

Safety Devices for Tramway Trolley Wires. Donald Smeaton Munro. Gives an illustrated description of various devices used for protection against accidents. 1500 w. Elec Rev, Lond—March 13, 1903. Serial. 1st part. No. 54303 A.

Steam Motor.

The Purrey Steam Tramway Motor (Automotrice à Vapeur, Système Purrey). L. Pierre-Guédon. Describing a steam-driven motor car used on certain tramway lines in Paris; a water-tube boiler is used. 3000 w. 1 plate. Génie Civil—Feb. 28, 1903. No. 54204 D.

Stray Currents.

See Gas Works Engineering.

Surface-Contact.

The Dolter Surface-Contact System. Illustrated description of this system and its operation. A line in France has been at work for over a year and is highly praised. 2000 w. Engr, Lond—March 13, 1903. No. 54199 A.

The Surface-Contact Tramways of the Bois du Boulogne (Tramways du Bois de Boulogne à Contacts Superficiels). E. Dieudonné. A description of the Dolter system, now being tried in Paris; the contact switches are operated by electro magnets carried on the car. 2500 w. Revue Technique—Feb. 10, 1903. No. 54-207 D.

Test.

Test of Subway Motors. An account of these tests, which were the most exacting ever made in electric railway practice, and of the methods employed. 2500 w. St Ry Jour—March 21, 1903. No. 54325 D.

Third Rail.

The Third Rail on the Baltimore and Ohio. W. D. Young. States some of the difficult problems involved in the installation, with illustrated description of the general form of construction. 4800 w. St Ry Jour—March 14, 1903. No. 54113 D.

Tracks.

How to Lay Interurban Track in Cities. Extracts from a letter presenting the points of difficulty to be overcome, and giving an invitation for discussion of the various subjects. 2200 w. Munic Engng—March, 1903. No. 53941 C.

Track Construction of the International Railway Co. in Buffalo, N. Y. T. W. Wilson. Begins an illustrated detailed description of fine construction laid on concrete with electrically welded rails. 1300 w. St Ry Rev—March 20, 1903. Serial. 1st part. No. 54339 C.

Valtelline.

Main-Line Polyphase Electric Traction in Upper Italy (Elektrische Vollbahn mit Hochgespanntem Drehstrom in Oberitalien). E. Cserhati. A general illustrated description of the Valtelline railway, using the Ganz system. Two articles. 4000 w. Zeitschr f Elektrotechnik—Feb. 22, March 1, 1903. No. 54242 each D.

We supply copies of these articles. See page 317.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Electrical Conductors.

Conductors for Electrical Distribution; Their Materials and Manufacture, the Calculation of Circuits, Pole-Line Construction, Underground Working, and Other Uses. By F. A. C. Perrine, A. M., D. Sc. Size, 9½ by 6 ½ in.; pp. VII, 287; illustrations, 84; folding plates, 5. Price, $3.50. New York: D. Van Nostrand Company. London: Crosby, Lockwood & Son.

The author of this book has had an extensive and varied experience as a manufacturer of insulated wires and cables, as an electrical engineer, and as professor of electrical engineering at Leland Stanford, Jr., University. The results of this experience are embodied in the present volume, different chapters of which are devoted to conductor materials; alloyed conductors; the manufacture of wire; wire finishing; wire insulation; cables; calculation of circuits; Kelvin's law of economy in conductors; multiple-arc distribution; alternating-current calculation; overhead lines; the pole line; line insulators, and underground conductors. The book is fully illustrated and there are five separate plates of wiring charts. The account of the manufacture of wire, both bare and insulated, and cables is particularly comprehensive, and the volume as a whole is a most valuable treatise on electrical conductors, and will be of the greatest interest and service to the electrical engineering profession.

Launch Building.

How to Build a Launch from Plans, with General Instructions for the Care and Running of Gas Engines. By Charles G. Davis. Size, 7¾ by 5 in.; pp. viii, 159; figures, 45; plates, 14. Price, $1.50. New York: Forest and Stream Publishing Co.

The rapid development of the gasoline engine during the past few years has furnished such a convenient and economical motive power for small boats that a launch is now within the reach of a great many people who have hitherto been obliged to content themselves with a rowboat or, at best, a sailboat. To some men and to most boys there is an added satisfaction in having a boat built by themselves, and to such prospective builders the present little volume will prove very helpful. After an introductory chapter on general considerations, the actual boat building is taken up, and, with the aid of a number of illustrations, detailed instructions are given for constructing a wooden launch about 18 feet long. Gas and gasoline engines and their care and operation are then discussed, and the book is concluded with a lot of useful "wrinkles."

Roads.

Road Conventions in the Southern States, and Object-Lesson Roads Constructed Under the Supervision of the Office of Public Road Inquiries, with the Co-operation of the Southern Railway. Bulletin No. 23. Prepared under the direction of Martin Dodge, Director. Size, 9 by 6 in.; pp. 89; plates, 11. Washington: U. S. Department of Agriculture.

The Office of Public Road Inquiries, of the U. S. Department of Agriculture, cooperated for a period of about five months during the winter of 1901-2 with the Southern Railway Company and the National Good Roads Association in an expedition for building object-lesson roads in the southeastern section of the United States. A train, loaded with road-building machinery, travelled through the States of Virginia, North Carolina, South Carolina, Tennessee, Georgia and Alabama, stopping at eighteen different places. At each stopping place object-lesson roads were built and good-roads conventions held. Much interest was aroused and the good-roads movement was given a strong impetus. The expedition described in this report is only one of the many good works in which the Office of Public Roads Inquiries has been and is engaged, and many bulletins and circulars issued by this office give accounts of good-roads activity in various sections of the country.

Roads and Pavements.

A Treatise on Roads and Pavements. By Ira Osborn Baker, C. E. Size, 9¼ by 6 in.; pp. VIII, 655; illustrations, 171. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The object of this book is to give a discussion from the point of view of an engineer of the principles involved in the construction of country roads and of city pavements. The discussion is limited to the subjects indicated in the title, but it

covers practically everything within these limits, in a manner both comprehensive and concise. The chapter list includes: Road economics; road location; earth roads; gravel roads; broken-stone roads; miscellaneous roads (including wheelways of steel and other material); equestrian roads and horse-race tracks; pavement economics; street design and city plans; street drainage; curbs and gutters; pavement foundations; asphalt pavements (including asphalt blocks, asphalt macadam and coal-tar roads); brick pavements (including the testing of bricks); cobble-stone pavement; stone-block pavement; wood-block pavement; comparison of pavements; sidewalks; and bicycle paths and race tracks. The real and fundamental value of the subject matter here outlined is enhanced by its systematic order and typographical arrangement. The author is the professor of civil engineering at the University of Illinois, and his book represents his knowledge of his profession as well as the results of years of observation and experiment; and it will be of great service in advancing the knowledge and practice of road and pavement construction.

Storage Batteries.

Storage Battery Engineering. A Practical Treatise for Engineers. By Lamar Lyndon, B. E., M. E. Size, 9½ by 6½ in.; pp. 382; illustrations, 177; plates, 4. Price, $3. New York: McGraw Publishing Co.

As its title indicates, this is a thoroughly practical work. By this is meant not a collection of mere rule-of-thumb matter, but a comprehensive and systematic treatise on up-to-date practice. While the fundamental principles on which all good practice is based are properly considered, not too much time is spent upon the purely chemical aspects of the lead accumulator, nor upon theoretical discussions. In the first part of the book, the storage battery itself is taken up, the lead cell alone being considered in full. After a general introduction, the different parts and the various types and styles of lead batteries are discussed in detail, their diseases diagnosed, and the remedies therefor supplied, and directions given for their installation, care, management and testing. The second part of the work deals with auxiliary apparatus, systems and applications of storage batteries, some of the topics treated being end cells, resistances, switches, boosters of all types, rheostats, circuit breakers, two-wire systems, three-wire systems and alternating-current systems. There have been many books written about the storage battery itself, although generally from a chemical, as distinguished from an engineering, standpoint, but this book is especially noteworthy for its very able discussion of the auxiliary apparatus which has taken the lead accumulator out of the laboratory and made it a commercial success in modern electrical plants.

Water Waste.

Water Supply and Prevention of Waste in Leading European Cities. Report to the Merchants' Association of New York by Columbus O. Johnson, Ex-Water Registrar of New York City. Size, 9 by 6 in.; p. 289. New York: The Merchants' Association of New York.

In anticipation of the appointment of the special water commission to investigate new sources of supply and check the prevailing waste, the Merchants' Association of New York, at its own cost, engaged Mr. Johnson to go abroad and investigate the water systems of the principal cities of Europe. He has collated some valuable information upon the whole subject of water supply, and more particularly upon the collection of revenue and the checking of waste, and the present report embodies the results of his investigations of the distribution of water, the detection and prevention of waste, and the system of accounts in the cities of Glasgow, Liverpool, Manchester, Birmingham, London, Paris, Cologne, and Berlin. Each city is taken up separately, and an appendix contains accounting forms and methods, water rates, and other statistics. An account is given of the operation in several British cities of the Deacon meter system for detecting and localizing waste, and considerable attention is paid to the use of meters in the different places visited. This report altogether is peculiarly opportune, and the Merchants' Association is to be commended on its public spirit in thus helping to solve the extremely important problem of an adequate and economical water supply for New York.

BOOKS ANNOUNCED.

Finances of Gas and Electricity Manufacturing Enterprises. By Wm. D. Marks. Second edition. Price, $1. Philadelphia: Consolidated Railway and Light Co.

A Systematic Method of Calculating the Dimensions of Direct-Current Dynamo-Electric Machines. By Carl Kinsley. Chicago: The University of Chicago Press.

An Alternating-Current Calculating Device for the Use of Electrical Engineers. By F. G. Baum. Second edition, revised and improved. Price $1. Stanford University, California: Stanford University Book Store.

A Text-Book of Field Astronomy for Engineers. By George C. Comstock. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

NEWS SUPPLEMENT

The Engineering Magazine—May, 1903

Coming Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Sec.: Dr. Richard Moldenke, P. O. Box 432. New York. Convention June 9-11, Milwaukee.

AMERICAN INSTITUTE OF ELECRTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 29-July 3, Niagara Falls. Regular meeting on fourth Friday of each month, 12 W. 31st St., New York. May 19: Papers on Induction Generators.

AMERICAN PARK AND OUTDOOR ART ASSOCIATION. Sec: C. M. Robinson, Rochester, N. Y. Annual meeting, July 7-9, at Buffalo.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 17, etc., Mackinac Island, Mich.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month. Annual convention, June 8, Asheville, N. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, June 22-26, at Saratoga.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual meeting, June 23-26, Detroit.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Sec.: P. W. Drew, Milwaukee. Next meeting, May 13-15, New Orleans.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Saturday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September, Atlantic City, N. J.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LEAGUE OF AMERICAN MUNICIPALITIES. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22, etc. Mackinac Island, Mich.

MODERN SCIENCE CLUB. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

MONTANA SOCIETY OF ENGINEERS. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Sec.: W. H. Morton, Utica, N. Y. Next meeting, July 15-17, at Detroit.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: James B. Cahoon, 136 Liberty St., New York. Convention, May 26-28, Chicago.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay, P. O., Boston. Regular meetings, second Tuesday in each month at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, July 1-3, at Niagara Falls.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th Street.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month.

Personal.

—Messrs. Mackenzie and Quarrier have been incorporated under the name of Mackenzie, Quarrier & Ferguson, with offices in the Engineering Building, 114-118 Liberty Street, New York. They will continue to represent the Harrisburg Foundry and Machine Works.

Mr. Thomas P. Egan, president of J. A. Fay & Egan Co., of Cincinnati, the manufacturers of wood-working machinery, was one of the visitors at New Orleans, at the National Association of Manufacturers' meeting, April 14th and 15th. Mr. Egan was the organizer and first president of this association, and he takes great pride in having such a distinction, as this body of men is one of the most influential in the country.

—Messrs. John F. Kelly, Ph. D., W. L. Fairchild and T. W. Kloman, have incorporated under the name of The John F. Kelly Engineering Co., to conduct a con-

sulting and contracting engineering business, with offices in the Singer Building, 149 Broadway, New York. All of these gentlemen have been connected for years with the Stanley Electric Manufacturing Co., Dr. Kelly being one of the inventors and engineers who have designed the famous S. K. C. apparatus, besides having made his mark in a great variety of other electrical work.

—Kilburn, Clark & Company, of Seattle, Wash., have been made the Pacific Coast sales and distributing agents of the Nernst Lamp Company, of Pittsburg, and have established branch offices in San Francisco and Los Angeles, Cal. The increasing volume of business from that section of the country has made necessary special attention to its demands.

—Mr. Edgar N. Smith, formerly roadmaster on the B. & M. R. Railroad in Nebraska, and before that on the N. Y., N. H. & H. Railroad and the Boston Elevated, has accepted a position with the Railway Appliances Company, giving his time particularly to the "Q and C-Bonzano" rail joint.

—Mr. H. Clay Moore, No. 816 Empire Building, Atlanta, Ga., has been appointed sole agent for the south-eastern part of the United States, for the Scaife and We-Fu-Go systems of water softening and purification, manufactured only by Wm. B. Scaife & Sons Co., of Pittsburg, Pa.

—Mr. J. E. Meek, of the Asbestos Department of the H. W. Johns-Manville Co., New York, recently visited Washington and Newport News.

—The directors of the Steam Boiler Equipment Company of New York have elected officers as follows for the ensuing year: President and secretary, E. H. Hovey; vice-president, Wm. McAdoo, former Assistant Secretary of the Navy; treasurer, Dr. P. J. Oettenger, all of New York.

—At the meeting of the council of the Iron and Steel Institute, held recently, it was resolved unanimously that the Bessemer gold medal for this year should be awarded to Sir James Kitson, Bart., M. P., past president, in recognition of his great services to the iron and steel industry of Great Britain. The presentation of the medal will be made by Mr. Andrew Carnegie, at the annual meeting on May 7.

Industrial Notes.

—The Bradley Manufacturing Company, of Pittsburg, have issued a neat and ingenious card which is a working model showing the valve and piston motions of the Willans central-valve compound steam engine, of which they are the American manufacturers.

—Men who use or employ chain blocks will be interested in the offer of the Yale & Towne Mfg. Co. of prizes for information from mechanics concerning Triplex chain blocks. This contest is open to all, practical statements being the only thing required, and not fine writing. There is no question that scientific chain blocks are as much a benefit to the man who pulls the chain as to the one who pays the bills; and any enlightenment on this subject is bound to be eventually profitable to both. Employers ought to call the attention of their foremen and mechanics to this offer.

—The Engineering Agency, Monadnock Block, Chicago, was started in 1893 by Mr. F. A. Peckham, at that time western manager of the "Enginering News." Mr. Peckham found in traveling about the country that he was constantly asked by manufacturers where they could find certain competent help. On the other hand, his office was visited every day by those who thought his paper might be able to assist them to positions. The Agency has grown steadily, and during the past ten years has secured positions for over 5,000 technical men. The registrations during the past two years have exceeded 3,000 and yet to-day the Agency has difficulty in securing enough competent men to supply all of the demands made upon it by companies that wish high-grade help. It is therefore using the "Want" columns of some leading papers throughout the country. Every person who registers in the Engineering Agency is obliged to give a complete record of his past experience and if the Agency thinks that the experience is not satisfactory it refuses to permit the applicant to register; if it does accept the registration fee, but finds upon investigating the references that he is not such a man as the Agency wishes to recommend, it returns to him promptly the registration fee. The care taken to register only competent men and to recommend always the right man for the right place, together

with an experience of ten years with the leading railways, manufacturing and industrial companies, enables the Agency to secure positions promptly for almost any high-grade technical man who can furnish a good record and references. Mr. F. A. Peckham, president of the Agency, was for twelve years with the "Engineering News"; Mr. A. B. Gilbert, treasurer, has recently completed over eleven years' work for the same paper, during six of which he was assistant manager; Mr. A. G. Frost, secretary, has been connected with the Agency for several years.

—The Westinghouse Air Brake Company will at once begin the erection of a new foundry, to be 320 feet long by 65 feet wide, and constructed of brick with steel frame. This foundry will be located just west of the present Air Brake works at Wilmerding, Pa., and has been made necessary by the greatly increased demand for castings used in the apparatus manufactured by this company. Owing to the development of the traction-brake business, the Air Brake Company's present foundry facilities have been overtaxed for some time past, and in order to insure greater efficiency in production and prompt delivery of material it has become necessary to provide greater capacity. This addition to the plant will materially increase the Brake Company's working force, now numbering about 3,000 men, the majority of whom reside in Wilmerding and vicinity.

—The Engineering School of Union College is one of the oldest technical schools in the country. Founded in 1845 with Prof. Wm. M. Gillespie at its head, it at once took a high rank and for many years was one of the few engineering schools in America. From the first the evident policy of the school was to adapt the thorough training of l'Ecole des Ponts et Chaussées, where Professor Gillespie had finished his technical education, to the demands of professional practice in a vigorous new country where resources and opportunities were abundant, and capital and professional precedent were wanting. From the characteristics impressed on the school at its foundation it has not departed; mathematics, economics, and adaptation may be said to have been the leading subjects in its permanent curriculum. The School has kept pace with the wonderful development in American technical education and in the increasing demands on professional training. For many years engineering only was taught; then when the principles of modern sanitary science came to be better understood, a course in sanitary engineering was established, and more recently the course in electrical engineering, now being greatly extended, was undertaken. During its whole history the school has stood for broad, fundamental training rather than narrow specialization, and during recent years its advanced entrance requirements have made room in the course for them, increased time and attention have been given to culture studies and increased academic training.

—The Brown Corliss Engine Co., of Corliss, Wis., recently received an order from the Middlesex & Somerset Traction Co., of New Brunswick, N. J., for one 16 and 30 by 42 inch horizontal cross-compound engine and one 18 and 34 by 36 inch vertical cross-compound engine, and also received an order from the American Locomotive Co., of Dunkirk, N. J., for one 26 and 42 by 42 inch tandem compound engine.

—About one year ago The Lozier Motor Company, of Plattsburg, N. Y., decided that on account of their large and growing business in the metropolitan district, it would be necessary to establish local headquarters in New York City, and a branch office was opened at No. 1 Broadway. The growing popularity of Lozier gasoline engines and the launches and yachts manufactured by The Lozier Motor Company soon made it apparent that it was necessary to establish local yards and shops to take care of trade in the metropolitan district, and last summer a tract of ground was purchased at Castle Hill Point, at the mouth of Westchester Creek, and work was immediately commenced on a factory with ample facilities to enable The Lozier Motor Company to better care for their local business. This plant has just been put in operation. It is located on a beautiful plot of ground overlooking the Sound. The main building is 200 by 60 feet, and a showroom and warehouse 100 by 40 feet is under process of construction. Marine ways for launches and yachts of all sizes built and equipped by this company are provided. As the prin-

cipal factories and machine shops of the Lozier Company are situated in Plattsburg, N. Y., on Lake Champlain, the work at the New York City plant will be largely confined to the building of large yachts and the installation of Lozier engines in launches and auxiliary craft; in fact, the primary object of this factory is to look after the interests of the patrons of the company in the vicinity of New York City. While no engines are manufactured at this plant, it is the intention of the company to carry a large stock of motors on hand for immediate delivery, and stock launches of this company can be seen on exhibition at all times, and deliveries made in the water on short notice.

—The Philadelphia Pneumatic Tool Company has secured a contract from the Lake Shore & Michigan Southern Railway Company to supply them with all the pneumatic hammers which they will use in the new Collinwood Shops and on the entire system for a period of one year. This contract is awarded after a competitive test of all the different makes of pneumatic tools. This company has also received large orders for chipping and riveting hammers and drills from the Wabash, the Delaware & Hudson and the Central of New Jersey railroads.

—The New York Continental Jewell Filtration Co. has been awarded a filter contract for the entire city of Ithaca, N. Y., besides the contract recently closed with Cornell University. This company has also received a large order from the Producers' Powder Co., of Ashburn, Mo., for a New York gravity type of filter.

—The Nugent Anti-Packed Telescopic Oiler is designed to lubricate any reciprocating bearing, such as the cross-head pin, eccentrics, and the double-disk crank pin of steam engines, and other similar bearings. The anti-packed joint is the new, novel and improved feature of this invention. The joints are 1-100 of an inch loose and yet not a drop of oil can leak or wast through them. They have no stuffing-boxes, washers or packing of any kind. Thus the friction, wear and jar is practically done away with and consequently the device will outwear the engine or piece of machinery to which it is applied. This oiling device forms a continuous conduit or channel for the oil from the stationary oil cup to the bearing which is to be lubricated. It will about treble the life of the cross-head pin, which usually wears out as fast again as the crank pin. It will save its cost in oil in a short time, over any other appliance, such as the wiper cup or grease cup. It enables the engineer to positively know whether or not the bearing is getting oil and it places the pin or bearing under the absolute control of the engineer at all times and enables him to run his engine continuously for ten years, if necessary, without having to stop to replenish the oil, because the oil cup is always stationary. By simply pulling out two cotter pins with the fingers, the telescopic tubes and head may be removed in a moment's time. The purchaser of this appliance takes no chances whatsoever, for perfect satisfaction is guaranteed and the money will be refunded any time within one year after the date of the purchase, if the oiler does not fulfill expectations.

—The Western Electric Company has bought a tract of land, comprising 109 acres, in the southwestern part of Chicago, where it will erect structures costing $1,200,000, for the manufacture of its products. This location is a very good one, being on Ogden Avenue, one of the main diagonal thoroughfares of the city, and also on two railroads, the Chicago, Burlington & Quincy and the Chicago & Western Indiana Belt Line, the latter making connections with all the other railroads entering Chicago. Plans have been made for cable works, machine shop, iron foundry and a power plant, which will all employ about 1,200 hands. This undertaking is in addition to the present large interests of the Western Electric Co., and will in no way curtail them.

—The American Blower Co. has recently opened an office at 615 Hale Building, Philadelphia, in charge of Mr. Benj. Adams, and another at 318 Frick Building, Pittsburg, in charge of Mr. H. P. Curtiss.

—The A. Leschen & Sons Rope Company, manufacturers of wire rope and aërial wire rope tramways, with headquarters at 920 to 932 North First Street, St. Louis, have just opened an office and warehouse at 1717-1723 Arapahoe Street, Denver, Colo., where they will carry a full stock of their various grades of wire rope, manila rope, etc. This

gives them four branch offices and warehouses in addition to their headquarters at St. Louis, viz.: 92 Center Street, New York City; 137 East Lake Street, Chicago; 85 Fremont Street, San Francisco; and the Denver office above referred to. The A. Leschen & Sons Rope Company not only manufacture all of the ordinary grades of wire rope, such as are made by other manufacturers, but they are also the sole manufacturers of the celebrated Hercules colored-strand wire rope and the patent flattened-strand wire rope. They also manufacture automatic tramways which load and unload automatically, several types of friction-grip tramways and single-line and two-bucket tramways.

—A continuation of flourishing business is reported by the Chicago Pneumatic Tool Co., of Chicago, and they are still compelled to work the forces at their various plants both night and day in order to fulfill requirements. This company is continually on the lookout for new devices which fit in with their line of pneumatic appliances of every description, and have within the past few months made several additions which are among the most perfect productions of their kind. The chief of these are a pneumatic hand rock drill, designated as the Chicago rock drill, and a compression riveter, which is called the Chicago compression riveter. These machines, although but very recently placed on the market, have already indicated, by the heavy sales immediately created, that they are up to the high standard demanded of all tools manufactured by the Chicago Pneumatic Tool Company. Both these machines are illustrated and fully described in attractive circulars which the company is mailing to the trade.

The entire business of the Consolidated Machine Specialty Co., including the patents, good-will and machinery of every kind, has been purchased by the Power & Speed Controller Co., of Boston. The business of manufacturing speed-controlling and speed-varying apparatus will be continued, but with new and greatly increased facilities. The factory has been enlarged and the mechanical construction and efficiency of the "Controllers" much improved; all the machines now being placed on the market are very strongly made, have a very high percentage of efficiency and wide range of speed. The Franklin Institute of Philadelphia has just awarded the Edward Longstreth Medal of Merit to this "Controlier."

—The Abendroth & Root Mfg. Co., located for more than 30 years at Brooklyn, N. Y., and which was burned out in July, 1901, has now completed in every detail the equipment of its new works at Newburgh, N. Y. The present plant consists of twelve acres with a frontage of nearly 1,000 feet on the Hudson River, is well supplied with dock facilities for export shipment and is located on the main line of the West Shore R. R., which in turn connects with the Newburgh terminal of the N. Y. Central, Erie and New Haven roads. To the west of the railroad track lie the foundry, machine and boiler erecting shops, 100 feet by 400 feet, and the pattern, carpenter and forge shops, 50 feet by 150 feet, while on the river side the spiral-riveted pipe, sheet iron, galvanizing and asphalting departments are contained in a building 200 feet by 200 feet. These buildings are equipped with the latest type of machines for the economical manufacture of their several products—pipes and boilers. First of these comes the Root spiral-riveted pipe, which when double galvanized is claimed to be without equal for exhaust steam, pump suction, the conveying of paper pulp, and for brine circulation, while in the asphalted finish it has for over 30 years proved its superiority for waterworks, irrigation, hydraulic mining and dredging purposes. This company also manufactures the celebrated Root sectional water-tube boilers which are made in units of from 16 to 500 horse-power. These boilers are well and favorably known both in the United States and abroad. Some of the most prominent power plants in this country are equipped with this boiler, among these being the boiler plant of the Baltimore and Ohio Railway tunnel at Baltimore. For isolated plants, especially in mining districts, no more convenient boiler is manufactured. Its design and adaptibility to varied conditions, and transportation to inaccessible places has been demonstrated for over 35 years, no single package weighing over 200 pounds. Its main characteristics are: high economy, rapid circulation, absolute flexibility, perfect suspension, truly sectional construction and efficiency. The A. & R. exhaust heads are also manufactured here.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Automobiles.

Pamphlet with half-tone illustrations and descriptions of Packard gasoline motor cars, their details and their manufacture. 9 by 6 in.; pp. 44. Packard Motor Car Co., Warren, Ohio.

Boiler Cleaner.

Pamphlet with illustrations and description of the Garrigus mechanical boiler cleaner, having a floating skimmer, which removes dirt, impurities and scale-forming matter, and conveys them to a precipitator, from which they are blown off. 9 by 6 in.; pp. 29. Also, booklet and folder devoted to this boiler cleaner. The Mechanical Boiler Cleaner Co., Chicago.

Boilers.

Catalogue, ninth edition, with descriptions and illustrations of the Almy patent sectional water-tube boilers for marine and stationary work, with views of the shops, report of test by Geo. H. Barrus, list of users, and pictures of many yachts and other vessels which have been equipped with these boilers. 5¾ by 8½ in.; pp. 63. Almy Water-Tube Boiler Co., Providence, R. I.

Car Loaders.

Catalogue No. 5, with illustrations and descriptions of the Ottumwa mechanical loader for loading coal, ore, lime, phosphate, sand and any other loose material into box cars, together with views of its operation and descriptions of its parts. 7½ by 9 in.; pp. 50. The Ottumwa Box Car Loader Co., Ottumwa, Iowa.

Centrifugal Pumps.

Catalogue No. 10, revised, with illustrations and descriptions of improved centrifugal pumping machinery, with double-swivel suction and discharge pipes, adapted to a great variety of service. 5¼ by 8 in.; pp. 52. The Lawrence Machine Co., Lawrence, Mass.

Chains.

Pamphlet describing and illustrating silent-running, high-speed chains, with the Morse frictionless rocker joint, for power transmission, and their various applications to pumps, electric motors and other machinery. 9 by 6 in.; pp. 19. Morse Chain Co., Trumansburg, N. Y.

Concentrator.

Catalogue No. 5—E, with illustrations and description of the 1903-model Bartlett table for concentrating ores, and useful information and practical data regarding concentration. 9½ by 6¾ in.; pp. 36. The Colorado Iron Works Co., Denver, Col.

Cutting-Off Machine.

Folder, with illustration, description and specifications of the Cochrane-Bly cold-saw cutting-off machine, of rigid and compact design and with convenient attachments. 9 by 6 in.; pp. 4. Cochrane-Bly Machine Works, Rochester, N. Y.

Drop Hammers.

Catalogue, with illustrated descriptions of drop hammers, equipped with Brett patent steam and compressed-air semi-rotary lifters and with friction board lifters, and of the Brett patent press clutch, together with illustrations of details, sample forgings, and works where these hammers are in use. 6 by 9 in.; pp. 24. E. W. Merrill, Jr., Brooklyn, N. Y.

Electric Apparatus.

Bulletins, supply catalogues, price lists, flyers, instruction book No. 8201, for series-enclosed arc-lamp street lighting systems, and other pamphlets, including an index to bulletins, devoted to electric machinery and apparatus of many kinds. General Electric Co., Schenectady, N. Y.

Electric Driving.

Bulletin No. 33, entitled "Electricity as a Motive Power for Machine Shops," containing an illustrated abstract from an article by William Burlingham, in *Machinery*, on the electrical equipment of the shipbuilding establishment of the Wm. R. Trigg Co., of Richmond, Va. 10 by 7½ in.; pp. 12. Crocker-Wheeler Co., Ampere, N. J.

Electric Machinery.

Bulletins devoted to electric generators and motors of various types, medium and slow speed, open, semi-inclosed and inclosed, and other high-grade electrical machinery. 9½ by 6¾ in. Also, booklet with partial list of installations of power and lighting machinery. Keystone Electric Co., 114 Liberty Street, New York.

Electric Specialties.

Illustrated descriptive catalogue and price list of hotel apparatus, carriage annunciators, burglar alarms, programme clocks, watchman's time detectors, bells, buzzers, gongs, fire alarms, keys, door and window springs, door openers, latches, push buttons, gas lighters, switches, and other electrical specialties. 9 by 6 in.; pp. 140. Edwards & Co., 405-409 East 144th St., New York.

Fan Motors.

Special publication No. 7,006, with illustrated descriptions of electric fans for alternating- and direct-current circuits and of both bracket and desk types, together with illustrations of some of the many adaptations of these fans, 8¾ by 5½ in.; pp. 15. Also, two booklets devoted to fan motors. Westinghouse Electric & Mfg. Co., Pittsburg.

Gas Engines.

Catalogue with descriptions and illustrations of stationary, portable, pumping and hoisting gas and gasoline engines, which will operate with gasoline, naphtha, benzine, distillate, crude oils, manufactured gas, natural gas and producer gas. 6 by 9 in.; pp. 32. Witte Iron Works Co., Kansas City, Mo.

Hydraulic Machinery.

Large catalogue (foreign edition), with descriptions and illustrations of hydraulic tools, cranes and machinery, including valves, shears, punches, flanges, presses, bulldozers, intensifiers, riveters, both fixed and portable, jib, tower and gantry cranes, accumulators, and other varieties of hydraulic machinery capable of performing the heaviest kinds of work. 8½ by 10½ in.; pp. 103. Also, large folder devoted to the Mond gas for power and heating, with by-product recovery. R. D. Wood & Co., Philadelphia.

Locomotives.

Record of Recent Construction, No. 41, entitled "Some Notable Trains," with illustrations and descriptions of various types of Vauclain compound locomotives in service hauling fast and heavy trains in different parts of the world. 6 by 9 in.; pp. 36. Baldwin Locomotive Works, Philadelphia.

Lumber Machinery.

Catalogue, with illustrations and descriptions of air cushions for saw-mill carriages, saw-mill cranes, logging-car stakes for holding a load securely and dumping it instantly, and direct-acting steam log loaders. 8 by 10 in.; pp. 16. Kilgore Machine Co., Minneapolis, Minn.

Plastic Metallic Packing.

Folder, illustrating and describing plastic metallic packing for high speeds, high pressures and heavy service on steam hammers, air compressors and pumps and all kinds of steam engines. This packing can be used in any stuffing box and can be applied without disconnecting the piston rod. 6 by 3½ in.; pp. 6. The Hileman-James Co., Pittsburg.

Portable Tools.

Catalogue for 1903, with illustrations and descriptions of portable boring bars, facing arms, facing spiders, valve-seat rotary plaining machines, locomotive-cylinder or dome facing machines, milling machines, crank-pin turning machines, radius planer attachments, eccentric mandrel turning machines, and other portable tools for railway repair shops. 9 by 6 in.; pp. 36. H. B. Underwood & Co., Philadelphia.

Portland Cement.

Book with descriptions of Portland cement and concrete and their manufacture, testing, applications, etc.; lists of users of Vulcanite Portland cement and many illustrations of buildings, bridges and other structures where it is employed. 9½ by 7½ in.; pp. 80. Vulcanite Portland Cement Co., Philadelphia.

Roller Bearings.

Booklet with illustrations and descriptions of roller journal bearings, roller end thrusts, ball end thrusts, roller-bearing axles, worm thrust bearings, taper roller thrust for propeller shafts, roller center and side bearings for trolley and railroad cars, roller-bearing shafting hangers, and other kinds of roller and ball bearings. 3½ by 6¼ in.; pp. 16. Standard Roller Bearing Co., Philadelphia.

Search Lights.

Bulletin No. 2, devoted to projectors and searchlights, with illustrations and descriptions of many types suitable for river and ocean steamers, naval vessels, fire departments, military use, etc. 10 by 7 in.; pp. 16. Also, bulletin No. 3, devoted to photo-engraving electric lamps, for newspaper and other work. Chas. J. Bogue, 213-215 Centre St., New York.

Shaking Grates.

Booklet, with illustrated descriptions of Foster shaking grates for steam boilers, in square, oblong and round styles and in all sizes, and for all kinds of fuel. These grates rest on legs and are entirely independent of furnace walls and boiler front. 7 by 4 in.; pp. 12. F. W. Foster Mfg. Co., 6 Portland St., Boston.

Steam Engines.

Catalogue No. 42, with illustrations and descriptions of portable and stationary, horizontal and vertical steam engines and boilers for agricultural and other uses, grates, smoke connections and stacks, steam and mud drums and other auxiliary apparatus. 6 by 9 in.; pp. 58. Nagle Engine and Boiler Works, Erie, Pa.

Pamphlet with illustrated description and specifications of high-speed, center-crank, automatic cut-off steam engines and their parts. 6 by 9½ in.; pp. 12. Liddell Company, Charlotte, N. C.

Steam Traps.

A novel publication, in the form of a legal document, containing "testimony in the matter of the merits of the Wright emergency steam trap," consisting of letters from users, a "summing up" with an illustrated description of the steam trap, and a thirty-days' trial offer and guaranty. Wright Manufacturing Co., Detroit, Mich.

Transformers.

Pamphlet No. 12, with illustrations and descriptions of transformers, their design, construction, testing and operation, with curves showing regulation, efficiency, etc.; and also an account of methods of doing business and liberal guaranties. 9 by 6 in.; pp. 28. Kuhlman Electric Co., Elkhart, Ind.

Turbines.

Catalogue with illustrated descriptions of Risdon cylinder-gate and register-gate turbines, Alcott high-duty turbines, Woodward governors, iron cases, penstocks, head-gate irons, gearings and harness for water-power plants, together with useful tables and information and list of references. 9 by 6 in.; pp. 120. Risdon-Alcott Turbine Co., Mount Holly, N. J.

Water Softening.

Pamphlet, with half-tone illustrations and descriptions of installations of water softening and purifying apparatus, by which hard water is made soft for all purposes, oil is removed from condensed steam, muddy water is cleaned, and water containing acid is purified. 9 by 6 in.; pp. 22. Industrial Water Co., 126 Liberty St., New York.

IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

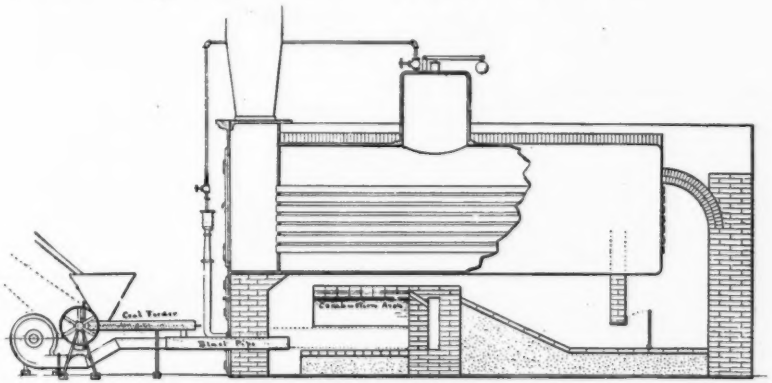
The Smokeless Calorific System.

IT generally takes some very striking occurrence to call people's attention to facts which they could easily ascertain by looking about them, but which they never seriously consider until matters are brought right home to them. Thus it took the plague of smoke from which New York suffered during the anthracite coal strike last summer to direct the mind of the general public to the possibility of burning bituminous and other kinds of coal besides anthracite without excessive smoke. This awakening of the popular interest in the subject led to the design of various methods for the prevention of smoke and the complete and economical combustion of coal.

One of the best and most successful of such systems is that of the Smokeless Calorific Company, which burns coal dust or powdered coal very completely in a firebox which can be used with any kind of a boiler.

The coal is taken just as it comes from the mine, and is reduced to a fine dust in a specially designed crushing and pulverizing machine. The coal dust may be led from the crushing machine to the feeding machine by a system of conveyors, or the crushing machine may be in immediate communication with the feeding machine. The former arrangement is shown in the illustration, in which the crushing machine itself does not appear.

The feeding machine consists of a worm operated by a disk and adjustable feed wheel. This machine receives the coal dust and feeds it at any desired rate, in the form of a fine spray, directly into the blast pipe, before the blast nozzle.



SMOKELESS CALORIFIC COMBUSTION SYSTEM.

The air for the blast pipe is supplied by a small blower, and when the air blast from the nozzle strikes the spray of fine coal falling from the feeding machine, there is a perfect admixture of the air and coal, which pass together into the combustion chamber into the form of a cloud of coal dust.

The furnace consists of a specially constructed firebox or combustion chamber having passages so arranged as to supply the needed oxygen to effect complete combustion. These passages admit the air in

such a manner as to render it impossible for any particles of coal to escape without being perfectly consumed.

When the cloud of coal dust from the blast pipe enters the combustion chamber, it is met by currents of very hot air from the air passages in the combustion chamber arch and instantly ignited, burning with an intense heat. The heated gases pass through currents of heated air into an auxiliary chamber behind the first, where any carbon which has escaped combustion in the first chamber is completely consumed before escaping to the flues and the uptake, although in many cases the second chamber is unnecessary.

Some of the special advantages of this apparatus are that the supply of air and coal is entirely under the control of the operator, as it can be instantly adjusted to feed greater or less quantities; the system is automatic, no handling being required after the fuel passes into the pulverizer; there are no grate bars, and consequently no fuel is wasted by passing unburned through the grates; and there is no cooling of the boiler by the opening of fire-doors. In general, there is an absence of smoke, a saving of labor and the complete combustion of the fuel.

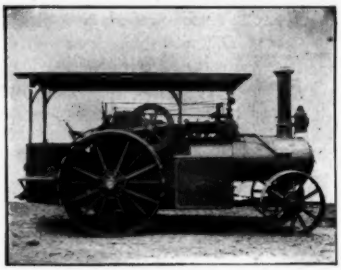
This apparatus has been tested in practical operation. It can be placed in any boiler now in use without disturbing the present setting, and will operate equally well with fire-tube or water-tube boilers of any type.

Further information concerning this system will be gladly given by the Smokeless Calorific Company, whose main office is at 66 Broadway, New York, and who purpose to open offices in every part of the country for the better handling of their business.

Road Locomotives vs. Horses.

ALTHOUGH road locomotives, so called, for the transportation by steam power of heavy loads of merchandise over ordinary roads, have become well established in England, there being numerous companies owning large numbers of such engines who make a business of contract hauling, it is a comparatively new proposition in this country. The increasing cost of horses, and of their keep, together with the manufacture in the United States of a superior grade of hauling engine, are however developing here a considerable demand for engines for hauling ore from mines, hauling lumber through forests and over country roads, for hauling road graders, hauling broken stone, brick, lime, cement and other heavy freight, and also for the plowing and breaking of new land.

The illustrations accompanying this article are of road locomotives built by the Buffalo Pitts Company, 10 Carolina St., Buffalo, N. Y., makers for many years



BUFFALO PITTS ROAD LOCOMOTIVE.

of traction engines, the house having been established in 1837. They have spared neither time nor money to perfect their engines for new lines of work, and claim to have today the most complete and varied line of engines for traction purposes that has ever been built. After a thorough test, their engines were found the only practicable means of hauling the graders used on the Saint Louis Exposition grounds, and some twenty of them were used there for this purpose. They made an average of plowing and loading 12 yards of dirt every minute, while with first class engineers and first class operators on the graders, 15 or 16 yards per minute were moved.

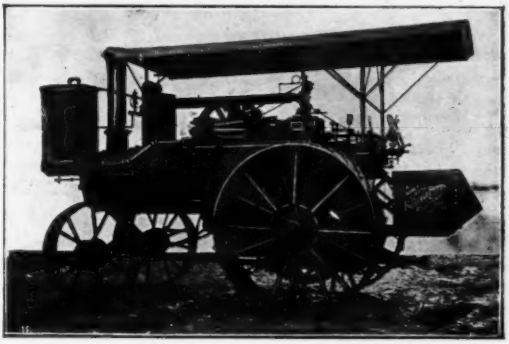
It is surprising to learn of the wide variety of conditions, as regards soil, with which these engines have successfully coped. In the rice fields of Louisiana and Texas they haul successfully through muddy swamps, in California over sandy wastes where horses can hardly travel, and in New England and in the West they

work successfully over snow and ice. In timbered country the engines need only room enough to pass between the trees, easily running over ordinary underbrush and small logs, and gradually making their own road bed. The engines without loads ascend grades of 30 per cent., while on grades of 20 to 25 per cent. loads of 20 tons can be hauled. Either coal or wood is

BUFFALO PITTS ROAD TRAIN.

used for fuel, sometimes oil, and in some sections straw. Special wagon cars are built for this traffic,—stone and ore cars, with or without stone spreading bottom, road freight cars with flat or box bodies, and logging trucks, with telescoping bolster guides. It is estimated that for cross-country transportation they save 60 per cent. of the cost of hauling by horses.

The Buffalo Pitts engines are double cylinder, thus avoiding the trouble of stopping on a dead center, and they start easily, without a hitch, and can be moved an inch or so at a time, if desired. The driving wheels range from 60 to 78 inches in diameter, and the tires range in width from 10 inches to two and three feet. For very light soils hauling engines with five-foot tires have been made. The Pitts engines carry a coal supply sufficient, on a fairly level road, for a trip of 20 miles, and a water supply for 10 miles, while provision is made to fill the tanks quickly, by an injector, from streams and pools on the roadside.



BUFFALO PITTS ROAD LOCOMOTIVE.

We give in some detail the specifications of the latest style of engine made by this company: This engine is of double-cylinder type with cylinders of 6⅝ inches diameter and 10 inches stroke. The cylinders are encased with live steam, thus preventing condensation. With 80 pounds mean effective pressure on the piston, and 500 feet of piston speed per minute, the engine will develop 83 horse power. All the shafts and axles are made of high grade forged steel, running in long boxes lined with babbitt metal, with ample provision to take up wear. Links and their connections are case hardened where wear takes place. The gear is of large diameter and wide face, made of steel. A compensating gear is used on the second countershaft, thus enabling the engine to turn sharp corners without slipping the road wheels. The first gear, both driver and driven, is cut from solid stock, as the speed is rather high for cast teeth. The road wheels have each a gear attached to their rims, thus removing the tension from the axle.

The road wheels have steel rims and flat steel spokes. The rim is reinforced on the edge next the boiler with angle steel. The spokes are riveted to the hub and rim, the hub being of malleable iron. The diameter of the wheel is 72 inches. The standard width of tire is 20 inches, but this is made wider to suit special conditions. The width outside of wheels is 8 feet, and the distance between front and rear axles 11 feet. The weight of engine in working condition is 11 tons. The grates burn either wood or coal, and are rocked by a lever from the platform. The tanks carry 400 gallons of water and about 1,000 pounds of coal. The crown

sheet of the fire-box is so sloped as to prevent its getting uncovered when descending ordinary grades. Gray iron castings have been practically eliminated, and steel and malleable castings substituted, thus reducing the liability of breakage to a minimum. This machine has a double shifting pinion, giving two speeds, varying from two to six miles per hour, at a constant speed of the engine. The speed of the engine may also be varied between wide limits by an attachment on the governor.

The engines of this company are made by the aid of electric power from Niagara Falls. For fuller details regarding their products address the Buffalo Pitts Company, 10 Carolina Street, Buffalo, N. Y.

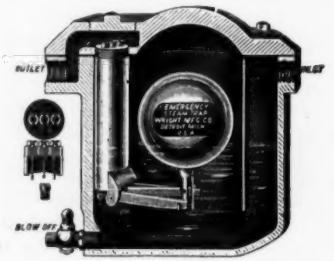
Emergency Steam Traps.

THE Wright emergency steam trap is the only one made that will discharge large volumes of water quickly when a sudden necessity arises and not waste steam in the operation. It marks a new departure in steam traps, but the principle of its design is so simple that no one with practical knowledge can question its success.

Three steam-tight outlet valves are employed instead of one. These valves are placed at the top of the trap as far removed from the inevitable dirt, grit and sediment as possible. The water enters, filling the trap to the center of the float and forming a seal of from four to six inches of water over the lower end of the outlet pipe, thus preventing the escape and waste of steam. When filled sufficiently to raise the float, one valve is opened slightly, if there is but little water coming in, but widely in event of a sudden inflow of water.

One of the valves is equal to the task of taking care of the water under ordinary conditions, but in event of the water coming into the trap faster than one valve can discharge it, the water rises in the trap, carrying the float with it and opening the second valve sufficiently to discharge the surplus water, or wide open if necessary, and the third valve operates in the same way if the volume of water coming into the trap is sufficient to tax the capacity of the three valves, which is very rarely the case. The discharge from each of these valves, being continuous, is very great—much greater than is possible with an intermittent trap. The action of this trap in emergencies is instantaneous. There are many uses for these traps where the emergency feature renders it invaluable.

The renewable valves are so placed that they may be cleaned, repaired or renewed without even taking the cap off the trap, by taking out the iron plug over the tube. All working parts are attached to the cap and are accessible without disturbing the piping. No steam can escape. The water is discharged from the bottom of a perfect



WRIGHT EMERGENCY STEAM TRAP.

water seal. The inlet and outlet are on the same line—a very important consideration in some cases, and never a disadvantage. A water gauge is provided for, with the aid of which the operation of the trap is always visible. The floats are seamless and round, the strongest possible form for a float, and are made especially for high-pressure service.

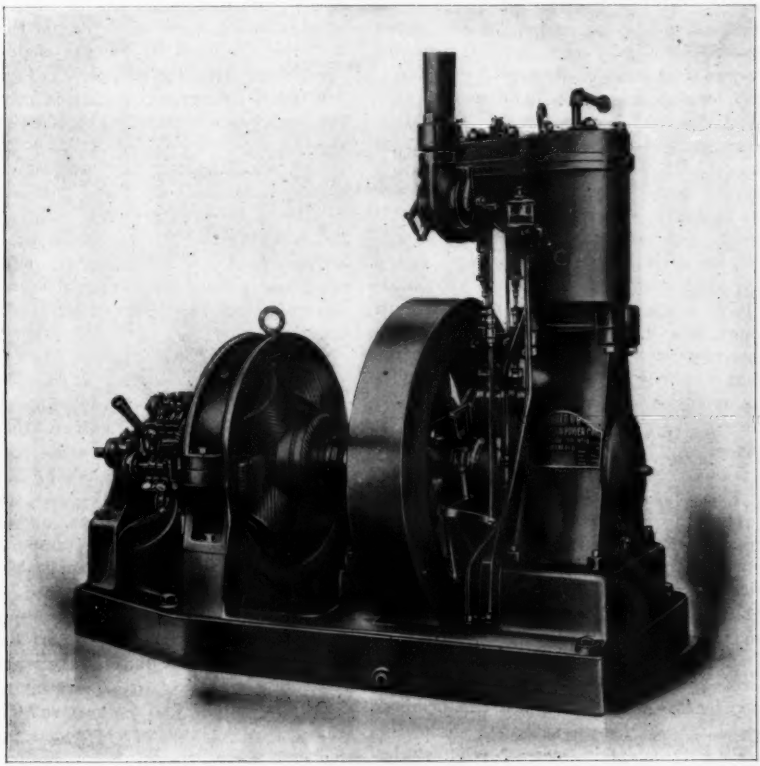
The Wright emergency trap is adaptable for use on all steam pressures up to 200 pounds per square inch, without requiring extra adjustment or change of valves. This is an important feature, as many other traps require special adjustments when used on varying steam pressures.

A blow-off is provided and the trap may be blown free from sediment as often as necessary. The materials and workmanship are first-class in every respect.

Any further information desired concerning these steam traps will be cheerfully furnished by the Wright Manufacturing Co., of Detroit.

The Secor Engine.

TO obtain power directly from fuel by means of a practical process embodied in a self-contained automatic machine, requiring neither boiler nor fireman, is a problem that has baffled the ablest engineers. The General Power Company offers the Secor Engine as its practical solution. Criticism from the steam-engine viewpoint shows, unquestionably, that this engine combines the industrial advantages of the steam engine, with the thermodynamic and labor-saving advantages of the gas engine. Its marketability is further enhanced by its capacity for utilizing low-cost fuels, especially the universally obtainable kerosene oil. It is the only engine which combines industrial adaptability with fuel availability and low operating cost. In mechanical design and construction it is fully equal to that of modern steam-engine practice. It can be easily, promptly and positively started. It ranks with the steam engine in mechanism, methods and performance. The superiority of this engine is well indicated by its governing efficiency. When used for electric lighting it has no necessity for multiple cylinders, nor a fly-wheel on its dynamo, nor an over-head jack-shaft fly-wheel, nor a governor controlled or flexible coupling between the engine and dynamo.



THE SECOR ENGINE.

The engine is self-contained; that is to say, it does not, like the steam engine, require a boiler and a considerable amount of storage room for fuel; nor does it, as in

the case of the gas engine, depend constantly on a supply of natural or manufactured gas of uncertain quality from the street main or from a special gas plant. In the Secor engine the fuel control is a function of the engine itself, the fuel being taken from a connecting reservoir which constitutes an integral part of the equipment. It has special advantages which accrue from its fuel and fuel method. Its cheaper fuel reduces the expense of operation below that of either steam or gas engine; its availability exceeds that of almost any other power source, by reason of the world-wide facilities for obtaining kerosene oil, and it is obvious that the increased safety due to the Secor method of using the fuel is advantageous alike to the user and the underwriter. As the basic idea of this engine includes and harmoniously coordinates all factors essential to high commercial efficiency, it is considered desirable to combine in its design the important elements of simplicity, reliability, strength, durability, compactness, interchangeability of parts, moderate weight and ready accessibility to all wearing parts. The simplicity which subordinates quality to cheapness is not considered desirable, for among the factors that contribute to its superiority are the mechanical excellence of its design and construction.

Every mechanical detail is the result of prolonged study and exhaustive working tests, the mechanism as developed being equal to that of the best steam-engine practice. It can be started as easily and certainly as an electric motor by means which automatically prevent an excessive supply of fuel. Regulation by variable pressure—every impulse stroke being effective—supersedes the inefficient "hit-or-miss" method. The fuel-supplying mechanism constantly maintains correct relations between the fuel and air under changing load; the quantity of combustible mixture being micrometically proportioned to produce the exact mechanical energy required to keep up the rated engine speed. This insures complete combustion, efficient regulation, and avoids fuel waste.

The special design, constructive and fuel-feed methods used in Secor engines are fully covered by design and construction patents.

Although electricians and manufacturers of internal-combustion engines have appreciated the great utility of producing a uniform electric current by means of a self-contained plant consisting of a single-cylinder gas engine solidly connected to a dynamo, its accomplishment was considered impracticable. The single-cylinder plant reduces to a minimum the number of parts and the opportunities for trouble. The Secor electric generating plant is actually direct connected; that is to say, solid coupled, using none of the appurtenances heretofore required by the gas engine for overcoming irregular voltage.

Wireless telegraphic apparatus operated by oil engines manufactured by The General Power Company was in continuous use during the army and navy manoeuvres of 1902. Tests made by the Signal Service of the United States War Department demonstrated that the regulation was perfect, although the entire electric load was being continually thrown on and off. Only alternating-current dynamos were used in these tests.

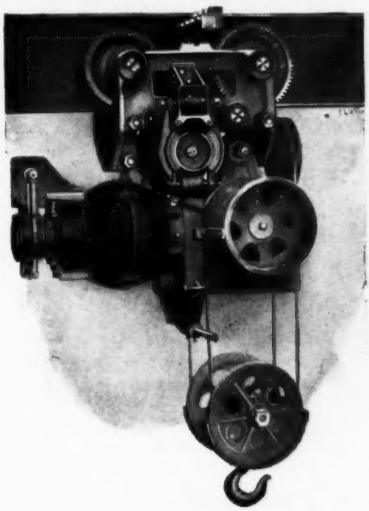
The General Power Company, 81-83 Fulton Street, New York City, makers of the Secor engine, are not only building special electric generating sets, such as the one shown in the cut, but also make compact direct-connecting hoisting, pumping and air-compressing plants. These are simpler than steam-driven equipments, and when water is scarce or bad, or transportation difficult, they are especially applicable, because kerosene oil can be obtained everywhere, and is easily and safely transported. The superior construction and performance of the Secor engine make these machines extremely reliable.

All the engine parts are actually interchangeable. This feature, added to the fact that these equipments can be knocked down and shipped in small packages, make them very desirable for remote and inaccessible localities.

Sprague Electric Hoists.

WHILE the simplicity of design and construction and great durability of Type W hoists, manufactured by the Sprague Electric Company, render their use desirable wherever possible, they are only applicable to situations

where the hoist can be controlled from immediately alongside the load, the operator following as the load moves. When the load is too hot to permit the hoist operator to approach within several feet of it, or the nature of the ground or floor is such as not to permit him to walk over it, or when the traversing speed is too high to permit the workman to comfortably follow the load on foot, then it becomes necessary to detach the controllers from the hoist itself and mount them either in a moving cage as in ordinary traveling cranes or at some convenient stationary point.



SPRAGUE ELECTRIC HOIST.

To meet these conditions the Sprague Electric Company has designed the Type W-A hoist shown in the accompanying illustration. The design and construction of this hoist is exactly similar to the Type W hoist, except that a magnetic brake is substituted for the mechanical brake and crane controllers for the cylinder switch.

The utmost attention has been paid to the design and construction of brake and controller and they are very much more durable and trustworthy than the brakes and controllers used on other hoists. They are designed so they can be easily and quickly repaired without interfering with the operation of the hoist for more than a few minutes at a time, and with very little trouble.

Type W-A hoists with motor-driven carriages are built with a traversing speed up to 600 feet per minute and when equipped with the trolley carriage as shown in the illustration will take curves of reasonable radius.

Electric Hoists for Docks and Wharves.

THE railroad and shipping companies time is always very valuable, so that any methods for facilitating the loading and discharging of freight and cargo are worthy of adoption. In spite of this well known fact the transportation companies, both rail and water, still rely upon large gangs of stevedores and hand or steam winches inconveniently located, to move the merchandise on docks and wharves. Large derricks and cranes take care of exceedingly heavy parts, but docks are seldom suitably equipped for hoisting bales, barrels and other pieces weighing from a few hundred pounds up to three tons. For such work as this the electric hoist is admirably adapted on account of the facility in handling it, its mobility, freedom from damage and repairs and its low cost of operation.

Electric motors are fast displacing steam engines and shafting on account of their economy in operation, and nowhere is this saving more apparent than in intermittent hoisting work. With electric hoists there is no loss due to condensation in long steam pipes, which loss frequently amounts to 25 per cent. of the power used, and there are no pipe lines with joints to be kept tight as with steam engines. With shafting the loss in transmission of power due to the friction at the bearings is very high. At one steamship dock in New York City, it was estimated that it took three tons of coal per day to run the shafting alone. This loss is practically eliminated with electric power.

An electric hoist may be stationary on the wharf where a great deal of work is to be done, or its base can be carried on wheels or it can rest on a small wagon. If the hoisting is to be done along the face of a dock the hoist may be mounted on a narrow-gauge railway car, the track for which extends the length of the dock. For supply-

ing power to portable hoists the electric mains are run to boxes stationed at intervals.

With a cable having a plug terminal which is inserted in the box, the hoist can be moved anywhere within the length of the cable; beyond this the plug is inserted in another box.

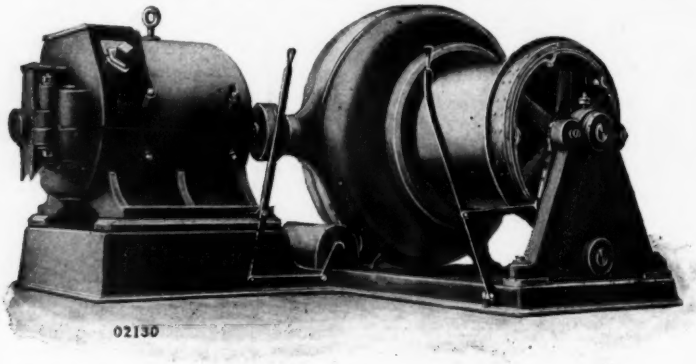
A 500-volt street-railway type of motor is usually employed for driving, but a direct or an alternating-current motor of any commercial voltage may be used.

The three essential parts of the hoist are the rope drum, the gearing and the electric motor. These are made in a series of sizes, and by a suitable combination of them a hoist may be built of any desired capacity and speed, within the limits of modern practice, to satisfy the user's convenience.

There are four factors that materially affect the size and cost of the hoist, namely the load, the speed, the height to which the load is hoisted and the frequency of the trips. These factors affect the size, operation and cost in the following manner: If the load is increased, the size, weight and strength of the mechanism will be increased; that is, a larger size must be used. If the velocity of hoisting is increased, the size and power of the motor will be increased, the other parts remaining the same. If the height to which the load is hoisted is increased the drum must be increased to hold a longer rope, the motor remaining the same. If the frequency of the trips is increased, the size of the motor will be increased, the other parts remaining the same.

There are three methods of operating electric hoists: 1. Running the motor continuously, hoisting the load by throwing a friction clutch and lowering by a band brake. This method is suitable either for alternating or direct-current motors. 2. Starting and stopping the motor for each lift, and lowering by a band brake. This is better suited for direct-current than for alternating motors. 3. Running the motor forward to hoist and backward to lower. A direct-current motor, with a reversing drum and switches, is used for this work.

The mechanism of the hoist is so arranged that any size or make of electric motor may be used. The motor is connected to the hoist by a flexible insulating coupling.



HUNT ELECTRIC HOIST.

The great flexibility of electric transmission allows hoists to be installed to advantage in many situations where it is difficult or inexpedient to use steam-driven machinery. One of the great advantages is that the expense for power begins only when the hoist is started, and entirely ceases when the motor is stopped.

The illustration here given shows one type of electric hoist, built by the C. W. Hunt Company for this particular class of work, and which possesses all the advantages enumerated above. The remarkable convenience of electric hoists for use on docks and wharves has been found an important element in their favor. They are always

ready for service by simply switching on the electric current for driving the hoist. When loading or unloading is completed the switch is opened, and the operator can leave the machinery at once.

Any further information desired concerning these hoists or other kinds of hoisting and conveying machines will be gladly furnished by the C. W. Hunt Co., of West New Brighton, Staten Island, New York.

Purifying Water by Electricity.

THE Clark electrical and mechanical liquid purifier is an apparatus for the purification of any liquid. It removes those substances held in suspension as well as the mineral and scale-forming materials that form some of the constituents of most water.

The water or liquid, upon entering the apparatus, is subjected to the action of an electric current which separates the mineral substances. All impurities of a greater specific gravity than the liquid are deposited at the bottom of the apparatus, where a series of blow-off pipes is arranged to eject them, and the removal of substances lighter than the liquid is effected in a dome provided with a surface blow attachment. The discharge of pure liquid takes place a few inches below the surface.

When the apparatus is provided with copper tubes running from one end of the main cylinder to the other it may be used as a feed-water heater, when fresh water is being purified, steam being then passed through the tubes, but when salt water is being decomposed, the heat generated is so great that the tubes must be used to circulate water to cool the liquid in the cylinder.

A great saving can be shown by this device in the manufacture of ice where distilled water is commonly used, as by this method pure water can be obtained without evaporation.

This system is thoroughly practical for purifying water for boilers, and the amount of electric current necessary for the decomposition of mineral substances is small when compared with the saving due to the prevention of scale. For locomotive boilers it would be necessary only to install a purier at the different water stations, and deliver pure water to the locomotives in the usual manner. This apparatus will be found very valuable for boilers on ocean and river steamers, as salt water can be used by means of this system and a great economy effected in the wear and tear of boilers.

This system will provide a simple and effective solution of the pure water problem for municipal plants, both large and small. It will purify dye liquids and sewage and has proved to be a rapid and economical method for the purification or aging of alcoholic liquids.

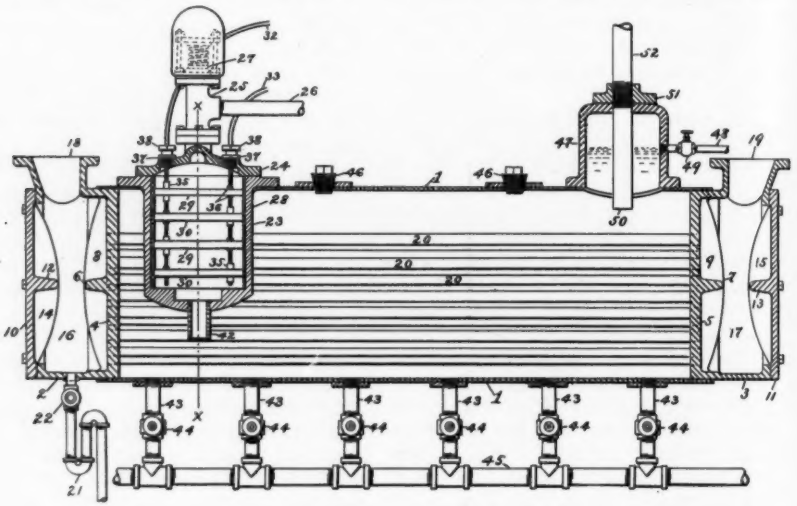
Referring to the illustration, it will be seen that a cylinder 1 is employed to make a close and tight receptacle, into the ends of which are secured circular heads having outer cylindrical rings 2, 3, which enter cylinder 1, and inner plates 4, 5, which form tube sheets, with stiffening ribs 6, 7, 8, 9; removable covers 10, 11, with ribs 12, 13, 14, 15 are secured to the heads, forming circulating chambers 16, 17, having openings 18, 19, to which may be attached the necessary pipes to convey cooling water or steam into or out of chamber 16, 17. Tubes 20 extend from tube sheet 4 to tube sheet 5, their ends being secured in expansion stuffing boxes. By means of tubes 20 the chambers 16, 17 are put in communication for the constant passing of cold water, or steam, to keep the liquid within cylinder 1 at a proper temperature for the purpose of the apparatus, the tubes not being in use when fresh water purification is in progress, but for salt water and other liquids (other than fresh water) a current of cold water enters chamber 16, goes through tubes 20 and is discharged at 19 to overcome the heat generated by the electric action upon the great amount of mineral substances.

When used as a feed-water heater and purifier, steam is passed through tubes 20, generally exhaust steam. A drain pipe 21 connects to the bottom of chamber 16, and valve 22 opens and closes the pipe, and is only used to take away the water of condensation when the apparatus is using steam.

An inlet chamber 23 is inserted through the cylinder, near chamber 16; it is secured to cylinder 1 and has a cover secured thereto; mounted above the cover is a T pipe 25, in which is inserted inlet pipe 26 for the

inflowing of the liquid to be treated, and above the T pipe is located a suitable relief valve 27, having means to relieve any excess of pressure above a fixed limit.

Within inlet chamber 23 is an insulated lining 28, and suspended within the lining is a series of electrodes, 29 being positive and 30 being negative; the electrodes will usually be of copper or graphite, and they have multiple perforations, through which the incoming liquid must pass and where it is electrolyzed, the heavier decomposed substances and matter held in suspension falling by gravity to the bottom of cylinder 1, and the lighter ones rising to dome 47. and can at any desirable time be drawn off through pipes 43 controlled by valves 44 and connected to discharge pipe 45, so that one or more pipes 43 and valves 44 may be used, and when a thorough cleaning is necessary washout plugs 46 may be removed, giving place for the introduction of hose or other means of washing out. Near chamber 17, at the opposite end of cylinder 1 from inlet chamber 23 is placed a dome 47, in which the light floating impurities are gathered, and where they may be drawn off by pipe 48 controlled by valve 49, while delivery pipe 50, secured to flange 51, descends below the dome and into the cylin-



CLARK ELECTRICAL AND MECHANICAL LIQUID PURIFIER.

The electrodes 29, 30 are connected to any suitable system of electrical generation, the current being conveyed by conductors 32, 33, having insulation 35, and nuts 36 screwed on conductors 32, 33, which are screw threaded for the purpose.

At the sides of cover 24 are insulated stuffing boxes 37, they being provided with follower caps 38, compressing insulating packing to prevent the outflow of liquids, an insulation being provided for part 38, and another insulation for part 37. A tube 42 delivers the electrolyzed liquid to the interior of cylinder 1, where the released impurities descend to the bottom, der to the body of pure liquid and, joining pipe 52, affords and outlet therefor. The action of the apparatus is continuous during the supply of liquid and the electric current, and is automatic when once set in operation, as the electrical current will flow in sufficient volume to attack the impurities as presented, a heavy current for many impurities and a lighter current as purification progresses, or when the liquid is more nearly pure to begin with.

Any further information concerning this apparatus and system will be gladly furnished by the American Electric Improvement Co., Drexel Building, Philadelphia.